# COMPARISON OF SHAPING AND INSTRUCTION INTERVENTIONS ON VERBAL AND NONVERBAL HUMAN OPERANT PERFORMANCES

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# COMPARISON OF SHAPING AND INSTRUCTION INTERVENTIONS ON VERBAL AND NONVERBAL HUMAN OPERANT PERFORMANCES

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The nature of interactions between verbal and nonverbal behavior has become an issue of some import in the experimental analysis of human operant behavior. In this research the effects of instructions on the contingency-sensitivity of human operant performances were investigated in three experiments. In Experiment I, subjects worked at a series of problem-solving tasks. They were required to negotiate a maze presented on a computer screen and then make guesses about the patterns of moving through the maze that would earn points. For some problems, subjects were given instructions about what to guess; for other problems guesses were shaped by contingent point delivery. A within-subject comparison of the verbal and nonverbal performances on these tasks revealed that sensitivity to scheduled contingencies was great under both conditions. Successful maze negotiation and successful guesses were acquired in all cases.

Experiment II arranged a concurrent problem-solving task such that one problem with instructed guesses and one problem with shaped guesses were available at the same time. Subjects were able to choose which of the two problem conditions to work under at any time. The contingency-sensitivity obtained in Experiment I was reproduced under these conditions. Furthermore, a small but reliable preference was shown for responding under the shaped guess conditions.

Experiment III also arranged problems concurrently. The concurrent pairings were designed to assess the possibility that the instruction condition of one pair member might influence performances on both pair members. No such generalized effects were demonstrated. However, sensitive performances were again obtained under both shaped and instructed conditions, and preference was indicated for responding when guesses were shaped.

Together, the data from Experiments I, II, and III support the conclusion that instructed human operant performances can prove to be sensitive to even subtle experimental contingencies. However, it was also argued that in order to obtain evidence of sensitivity scheduled consequences must be of reinforcing value to the subjects. In this research, points associated with increasing mastery over an experimental task appeared to be very effective reinforcers, while the accumulation of points beyond mastery was not always as effective.

# CHAPTER I

# INTRODUCTION

## Historical Context

Skinner began to draw distinctions between the effects of contingency-shaped behavior as opposed to rule-governed behavior in 1963. Conceptually, his writings since that time (e.g., 1966, 1969a, 1974) have argued that behavior directly controlled by contingencies of reinforcement is functionally different from responding under the discriminative control of rules. No matter how topographically similar the responses, the controlling variables are said to be different, and thus, so are the operants.

In addition to avoiding the formalistic fallacy, Skinner (e.g., 1966) has pointed out other important reasons for differentiating between rule-directed and contingency-shaped behaviors. Rules can often supplement or enhance the control over responding by its natural consequences. In some cases, rules are particularly helpful because they can generate apropriate behavior without lengthy exposure to the natural contingencies of reinforcement. Therefore, contingencies that are long-deferred or that would allow unwanted or wasteful behavior can be circumvented. Contingencies that are long lasting, as well as those that only rarely contact an individual's behavior, can also be quickly and easily transmitted to others. Similarly, behaviors likely to be forgotten or those controlled by contingencies that might weaken over time can be strengthened by the appropriate rule.

Skinner (1966) went on to argue however, that rules can not be substituted for contingencies of reinforcement. For example, contingency and rule control differ in terms of motivational effects. While contingencies change the probability that future responses will occur, rules set the occasion for a given response only by virtue of the attendent reinforcement pattern. In addition, contingencies exist that cannot be fully described. Thus, rules are often much simpler than the contingencies they supplement, and the resultant behavior is necessarily different. Finally, rules may be troublesome to the extent that they do not accurately represent the actual contingencies, especially when contingencies change and the rules do not.

In recent years, Skinner's conceptual and empirical distinctions between rule-governed and contingency-shaped responding have prompted considerable experimental attention. The issues have typically been addressed by contrasting the performances of subjects exposed to specific experimental instructions and subjects given either no instructions or instructions that differed along some dimension. In this literature, the verbal stimuli provided by experimenters have often proved to be potent sources of control over subjects' nonverbal responding. Although there are many different issues concerning instructional control, one question has dominated this literature. What are the effects of instructions on response sensitivity to schedule contingencies?

## Reported Effects on Sensitivity

A number of investigations have reported increased schedule sensitivity as a function of instructions. In one approach, instructions have sometimes proved necessary to induce initial instances of a target behavior (e.g., Ayllon & Azrin, 1964). A second line of evidence shows that instructions are often useful in enhancing the acquisition of response patterning (e.g., Azrin, 1958; Baron & Kaufman, 1966). A third indication of increased sensitivity is provided by instructions that have occasioned differential responding across components of mulitple (Baron, Kaufman, & Stauber, 1969; Scobie & Kaufman, 1969; and Galizio, 1979) and concurrent (Frazier & Bitetto, 1969) schedules and changes to extinction conditions (Weiner, 1970).

In contrast to these investigations, other studies have detected a decrease in schedule sensitivity as a function of instructions. In some cases, instructions have produced response patterning that persists despite incompatibility with efficient schedule performance (e.g., Kaufman, Baron, & Kopp, 1966; Lippman & Meyer, 1967). Other investigations have found characteristic schedule performance when the experimental operant was shaped, but not when it was instructed (Matthews, Shimoff, Catania, & Sagvolden, 1977; Shimoff, Catania, & Matthews, 1981). More recently, several studies have shown that even when the performance following instruction appears schedule-sensitive, further schedule manipulations may reveal that control resided with the instructions rather than the contingencies in effect (Hayes, Brownstein, Zettle, Rosenfarb, & Korn, 1986; Hayes, Brownstein, Haas, & Greenway, 1986; Shimoff, Matthews, & Catania, 1986).

These questions about the effects of instructions on schedule sensitivity have been extended to verbal behavior as well. For example Catania, Matthews, and Shimoff (1982) reported that control over verbal responding was more difficult to obtain with shaping contingencies than with instructions. However, once control was achieved, a subject's shaped verbal statements seemed to exert more influence over nonverbal responding than did instructed verbal statements. When shaped statements conflicted with reinforcement requirements for key pressing, the nonverbal responding tended to be less contingency-sensitive than when instructed statements differed from the schedule.

Matthews, Catania, and Shimoff (1985) again demonstrated the potency of shaped verbal responding was demonstrated again when the exact nature of the statement that was shaped seemed to determine its influence on subsequent nonverbal responding. In this case, shaped descriptions of nonverbal performance produced more control (i.e., less sensitivity to a conflicting schedule) than did shaped descriptions of the actual contingency.

In a third study, however, the same group of researchers (Shimoff, Matthews, & Catania, 1986) reported that even though the performances that followed shaped contingency descriptions had appeared characteristic of the schedule, subsequent schedule manipulations revealed that they, too, were rule-governed and not really sensitive to the schedule at all (i.e., they were "pseudosensitive"). Unlike in their previous studies (Catania et al., 1982; Matthews et al., 1985), this report did not attempt to specify particular characteristics of the verbal behavior responsible for the noted lack of sensitivity (e.g., its method of establishment). Instead, the very presence of verbal behavior was now targeted as a source of insensitivity. The conclusion that verbal behavior produces insensitivity has also been reached by others (e.g., Hayes, Brownstein, Haas, & Greenway, 1986; Hayes, Brownstein, Zettle, Rosenfarb, & Korn, 1986; Lowe, 1983; Lowe, Beasty, & Bentall, 1983; Bentall, Lowe, & Beasty, 1985).

The earlier differences in schedule sensitivity that were reported for shaped versus instructed verbal behavior (Catania et al., 1982; Matthews et al., 1985) are now unclear. Should they be considered examples of undiscovered pseudosensitivity? What might account for such differences, given the argument that verbal control is exclusive of control by contingencies (Shimoff et al., 1986; Lowe, 1979, 1983; Lowe et al., 1983; Bentall et al., 1985). It seems appropriate to conclude that the exact nature of instructional effects on contingency sensitivity remains unsettled.

## Differing Explanations

Explanatory accounts of this literature have varied. Some researchers have emphasized the nature of the contact between instructed performances and programmed contingencies (e.g., Baron & Galizio, 1983; Perone, Galizio, & Baron, in press). Behavior patterns that both correspond to experimental instructions and satisfy schedule requirements sufficiently well to yield some level of reinforcement would be expected to continue despite incongruity with the schedule structure. A related view contends that the relative control exerted by instructional stimuli and by schedule parameters is a function of a set of reinforcement contingencies that may extend beyond the immediate experimental setting (e.g., Hayes, Brownstein, Zettle, Rosenfarb, & Korn, 1986; Hayes, Brownstein, Haas, & Greenway, 1986). In other words, not only is the formal reinforcement schedule important but so is the history of social consequences for instruction-following. These accounts are similar in that they ascribe instructional effects to the same principles and variables used to explain nonverbally controlled performances.

Other conclusions have been drawn, however. The most extreme view interprets the relative potency of instructions over schedule control as evidence against any importance of reinforcement contingencies for human behavior (e.g., Brewer, 1974). This somewhat reactionary position comes from outside of the discipline, but interpretations of verbal control have emerged from behavior analysis that also seem to depreciate the influence of direct reinforcement contingencies for human behavior. In fact, because verbal behavior is unique to humans, some researchers have been critical of those who are "reluctant to go beyond findings of animal research in constructing a theory of human behavior " (Bentall, Lowe, & Beasty, 1985), and others have argued that, due to verbal behavior, human performance is not "sensitive to contingencies in the same way as infrahuman performance" (Shimoff, Matthews, & Catania, 1986). Even the term "rule-governed behavior" has become controversial by implying a distinction between control by rules and control by contingencies (e.g., Brownstein & Shull, 1985).

Of particular interest here is the increasingly popular conviction that instructional stimuli inevitably decrease sensitivity to schedules. Indeed, insensitivity has come to be accepted as a defining feature of instructional control by some (Shimoff et al., 1981). Thus, any responding accompanied by verbal behavior, either overt or covert, can be characterized as insensitive (Shimoff et al., 1986; Lowe, 1979, 1983). Even responding that appears well-matched to the schedule structure could have its "pseudosensitive" nature demonstrated with "sufficient experimenter ingenuity" (Shimoff, Matthews, & Catania, 1986). Taken to its extreme, this argument suggests that insensitivity is a pervasive property of most human behavior, given our instruction-laden environment (Shimoff et al., 1986).

This issue of instruction effects is obviously important for practical applications. Most of the institutions of social control, such as family, governmental, and religious institutions, can be characterized by a heavy reliance on instructions as a mechanism of behavior change and maintenance. Perhaps foremost among these examples is an educational system that focuses primarily on changing students' verbal behavior via instructions, although it involves nonverbal behaviors in technical training, laboratory work, apprenticeships and practicums. Evidence that current practices are responsible for creating repertoires insensitive to modification or refinement by subsequent contact with their natural consequences would have sweeping implications. These concerns have also been expressed with respect to clinical procedures (Hayes, Brownstein, Haas, & Greenway, 1986). Similarly, because instructions are often involved, this position has strong implications for the typical experimental procedures that are used to investigate the behavior of verbal human subjects. Before extending the findings of a few documented cases of instruction-induced insensitivity to all instructional practices, however, important issues remain to be addressed.

## Conceptual Considerations

This interpretation of instructed human behavior seems inappropriately narrow. Insistence on an inevitable insensitivity of instructed performances (e.g., Shimoff et al., 1986) certainly does not follow from much of the experimental data that constitute the human operant literature. Although the use of instructional stimuli is common throughout this literature, human performance that does not show the effects of contingency manipulations is unusual even if response patterning is sometimes at variance with that of other animal species (but see Perone, Galizio, & Baron, in press).

Neither does the conclusion of inevitable insensitivity follow from Skinner's conceptual analysis of instruction- or rule-governed behavior. While maintaining the distinction between rule and contingency control, Skinner (1966) pointed out that rules usually generate appropriate behaviors without the lengthy exposure to contingencies that would otherwise be necessary. Sensitivity to more slowly learned contingencies such as those that are long-deferred, subtle or inconsistent, or occur only rarely might be particularly likely to increase with instructions. Once the appropriate behaviors are generated and make contact with contingencies, the natural consequences may take over as a direct influence (Skinner, 1963). Skinner's reasoning is that behavior can make contact with its consequences more expediently when occasioned by prior verbal stimuli than when each response element must be shaped. In fact, he goes on to point out that "The reinforcements contingent on prior stimulation for maxims, rules, or laws are sometimes the same as those which directly shape behavior" (Skinner, 1963, p.

148). Rule-following that is consequated by the natural effects of the behavior, as opposed to socially mediated reinforcers, has been termed tracking (Zettle & Hayes, 1982; Hayes, 1986; Hayes et al., 1986). Discriminative stimuli produced in this way do not seem likely to yield an inevitable insensitivity to the contingencies in effect.

Finally, concluding that instructions always produce a decrease in contingency sensitivity seems inconsistent with a functional cultural analysis. Such an analysis would have difficulty in accounting for the continuation, let alone the proliferation, of a practice that consistently led to inefficient performance. Even if it were argued that insensitivity to some consequences might be a good thing (e.g., the short-term reinforcements of drug use), certainly many other critical contingency relations demand sensitivity for both phylogenic and ontogenic reasons. Any cultural practice that inhibits precise control by such contingencies would be unlikely to continue, much less to reach the pervasive stature characteristic of instructions. Indeed, scholars of cultural analysis have argued that the very success of a practice such useing instructions (seen as a phenomenon of the structural level of a culture's organization) depends on the way in which it affects the more basic and fundamental contingencies of production and reproduction (phenomenon of the infrastructural level) (Harris, 1977, 1980, 1981; Malagodi, 1986). While attempting to avoid the Panglossian assumption that instructions must necessarily serve an adaptive function at this time, the question of continued widespread dissemination of a cultural practice that inevitably interferes with sensitivity to selection by vital contingencies warrants careful, if not skeptical, consideration.

## Methodological Considerations

### Limiting Methodological Features

In addition to these theoretical concerns, there are also methodological issues that may place limits on the generality of the conclusion that instructions produce insensitivity. One such issue concerns the fact that most of the putative demonstrations of insensitivity have been obtained with instructions that incorrectly described the contingencies in effect. In these cases, insensitivity is argued when the ensuing performance matches the specifications of the instructions more closely than the contingencies of the programmed schedule. An alternative explanation is that such performances are under the control of the stronger of a pair of competing contingencies (e.g., Baron & Galizio, 1983). To suggest that the discriminative control exerted by instructional stimuli may be greater than the contingencies of the experimental schedule seems quite reasonable. Subjects' pre-experimental histories of responding to other's instructions, particularly in a novel environment, are likely to be extensive. Furthermore, for a number of the investigations in question, performance in accordance with instructions resulted in reinforcement prior to contacting contingency manipulations, which should also increase the liklihood of instructional control (Galizio, 1979). Furthermore, even when judged to be insensitive, these performances resulted in some level of reinforcement. To argue that the instructional control demonstrated under such conditions represents true insensitivity to the schedule seems premature at best. In the presence of concurrently programmed but opposing contingencies, it might be expected that performance would come to be controlled more by one than the other due to specifiable features of the respective contingent relations. However, there can be no basis on which to judge schedule sensitivity when more powerful instructional contingencies are able to preclude or override schedule control. Thus, opposing instructions and schedule requirements may be an important strategy for investigating the relative control of the two sets of contingencies, but this procedure seems poorly suited for analyzing sensitivity.

The effects of instructions on schedule performance when reinforcment is contingent on performances that are extremely sensitive to contingencies, and not to instructions, remain relatively unexplored. However, there are some data to suggest that when instructed responding is not reinforced but contingency-sensitive performance is, it is the contingency-sensitive performance that is maintained. For example, when the interval between monetary losses was decreased to five seconds in all components of a multiple schedule, avoidance responding adjusted immediately from its slower instructed rates (Galizio, 1979). In this case, sensitive performance was required in order to avoid the monetary loss, and instructed response rates resulted in no reinforcement. Thus, it would seem that procedures that provide ample reinforcement for instructed responding and do not require contingency-sensitive responding constitute only one of several possible arrangements and therefore represent a limited exploration of instruction effects on sensitivity.

Another methodological feature that deserves special attention when making judgments of insensitivity is the length of exposure to schedule contingencies. Again, a majority of the investigations that have reported instruction-induced insensitivity are characterized by durations of total experimental time between one and six hours. During this period, subjects are exposed to at least two and often as many as six different schedule conditions, and judgments of sensitivity are based on performance changing with the contingencies. This research tactic is sufficient for demonstrations of initial insensitivity; however, it leaves unaddressed factors that would seem important to a conclusion of inherent insensitivity, for such conclusions at least imply that the effect is more than transitory.

When exposure to experimental contingencies has been continued beyond early indications of insensitivity, the development of sensitive performance has sometimes been revealed. For example, subjects whose performance on a color discrimination task was instructed showed perseveration of incorrect responding at the first reversal of S+ and S- stimuli (Robinson & Storm, 1978). However, subsequent reversals resulted in many fewer errors for the instructed subjects than for those who had originally learned the discrimination only through contact with the contingencies. Such data indicate that insensitivity produced by instructional control may not be durable. If this is the case, insensitivity may be unimportant for many practical purposes and better studied by exploring its parametric characteristics. In either event, the experimental practices characteristic of many insensitivity studies leave us unable to assess the temporal generality of their conclusions.

### Alternatives of these Methodological Features

The present argument is certainly not meant to imply that there are no cases in which instructions will result in less than optimally effective performance. Rather, the conclusion of insensitivity as a defining characteristic of instructional control is at issue. An alternative to the argument for instruction-induced insensitivity is that instructions may in some cases serve the useful function of bringing behavior into initial contact with important consequences so that these consequences might acquire control (e.g., Skinner, 1966). The view that instructions inherently decrease a performance's sensitivity to its contingencies would seem antithetical to such a possibility. It is not clear how behavior that was insensitive to its consequences would come under their control. In the attempt to reconcile these differing perspectives, it may prove helpful to consider the conditions under which behavior initially engendered by instructional stimuli would be most likely to come under the influence of its programmed or natural nonverbal consequences.

Several factors that would seem to enhance such transfer of control have been addressed. First, sufficient exposure to schedule contingencies is an obvious prerequisite to their acquiring control. Although no clear guidelines exist for what constitutes "sufficient" exposure, precedents from steady-state research strategies (e.g., Skinner, 1957; Sidman, 1960) suggest that the time necessary for a new schedule to acquire full control may extend over several experimental sessions. Increasing the extent of exposure to experimental contingencies would thus provide further opportunity for sensitivity to develop.

A second condition that should enable natural consequences to more readily influence instructed responding involves the accuracy of the instructions. Instructions are unlikely to result in contact with and subsequent control by natural consequences when contingencies for following instructions are strong and the instructions specify response characteristics that do not match schedule demands. Conversely, instructions accurately describing critical elements of the programmed contingencies are likely to result in performances similar to those required by schedule properites. Arranging contact is likely to provide greater opportunity for contingencies to begin to impact responding.

Finally, in order to facilitate sensitivity to the programmed contingencies, more than just the opportunity for contact should be provided. Transfer from instructional to contingency control may not occur automatically with contact. When performances under the control of instructional contingencies produce some reinforcement, that control may be maintained, despite contact with schedule variables. Sensitivity to schedule characteristics is largely unnecessary in such situations, and pseudosensitivity may result. In contrast, it should be possible to arrange specific contingencies such that sensitive performance is required in order for consistent reinforcement to be obtained. Sensitive responding would not only be reinforced, but at rates far greater than those obtained by insensitive performance. When contingency sensitivity is required for reinforcement (i.e., directly selected for), it would be more likely to become prominent.

The goal of the present research was to incorporate each of the factors outlined above into an extension of the work on instructional effects and contingency-sensitivity. The questions addressed here concern systematic exploration of the effects of instructional stimuli when delivered under conditions conducive to sensitivity. Longer contingency exposures, reinforcement conditions that more actively support sensitive performances, and accurate instructional stimuli can all be arranged. The challenge for such an arrangement, as put forth by Shimoff et al. (1986), is to still allow for differentiation between true contingency influence and "pseudosensitivity."

The tactic adopted for accomplishing this goal is to provide instructional stimuli that, although accurate, are incomplete statements of the programmed contingency. (Indeed, Skinner, 1963, has argued that instructions are often incomplete descriptions.) For research purposes, incomplete descriptions can provide enough direction to enable behavior to make contact with contingencies more quickly than would be the case for uninstructed responding. However, successful (i.e., reinforced) responding will still require contingency sensitivity because of the incomplete nature of the description. "Pseudosensitivity" as a result of instructions will not be an issue because instructions alone can not generate successful performance. Contingency contact will be the only possible source of consistently reinforceable response patterns, which will directly encourage sensitivity.

The present research also attempts to provide an improved resolution of instructional effects by adapting this tactic to a within-subject design. To date, the literature that reports decreased contingency-sensitivity as a function of instruction delivery is characterized by between-subject comparisons of variously instructed performances (cf., Galizio, 1979, who found insensitivity only when instructed responding did not contact schedule variables). By using a within-subject analysis, neither the typical performance of nonhuman animal species, nor the responding of other human subjects has to serve as the basis for determining sensitivity. Furthermore, analyzing the functional relations of a few subjects in detail is a strategy well-suited to revealing variables that may be critical for the sensitivity of instructed performances. The benefits of thorough-going single-subject analysis with a limited number of subjects when pursuing an experimental analysis of behavior have been discussed extensively (e.g., Skinner, 1969a; Sidman, 1960; Johnston & Pennypacker, 1980).

# CHAPTER II

## EXPERIMENT I

Experiment I was designed to explore further the nature of the influence that instructions can have on contingency sensitivity. The procedure was designed as a systematic replication of the work of Catania et al. (1982), Matthews et al. (1985), and Shimoff et al. (1986), who demonstrated that the sensitivity differences resulting from instructional versus shaping procedures may be revealed even when the response being instructed or shaped is itself verbal. Such a procedure enables investigation of the effect of instructions on both verbal and nonverbal responding simultaneously. The major variation from the procedure used by Catania et al. (1982) was the nonverbal operant task employed. In the present case the task was designed to provide within-subject comparisons of instructed and shaped responding on several different measures of sensitivity.

### Methods

#### Subjects

Subjects in this experiment were five University of Florida undergraduates. Participation in this experiment was one option for earning extra credit points in an Introduction to the Experimental Analysis of Behavior course. Subjects who attended all experimental sessions earned twenty extra credit points towards their class grade. They were also paid $.05 per point earned on the operant tasks described below. Each subject completed ten two-hour sessions held consecutively on Monday through Thursday evenings. At the beginning of each session subjects were informed of their earnings from the previous session and their cumulative total earnings. They were paid for the total at the end of their final session.

### Apparatus

Subjects sat in individual cubicles facing the monitor and keyboard of a Terac microcomputer system. The monitor displayed a 5 x 5 grid of unfilled squares. At the start of each trial, the top, rightmost square of the grid was filled. The four arrow keys (i.e., up, down, right, and left arrows) were the only ones operable on the subject's keyboard. A press on one of these keys moved the filled square one space on the grid display in the direction of the arrow that was pressed. Sequences of key presses moved the filled square from its starting point through the grid to the goal position (i.e., the bottom, leftmost square of the grid). When key-press sequences satisfied reinforcement contingencies, a point was added to a counter display located on the far left side of the monitor, and a tone sounded. Whether or not a point was scored, the filled square immediately reset to its starting position upon reaching the goal.

## Procedure

In a procedure like that used by Catania et al. (1982), Matthews et al. (1985), and Shimoff et al. (1986), subjects responded for points on two different operant tasks. The first task involved responding on the apparatus described above. Points were awarded contingent on particular sequences of key presses. In the second task, points were made contingent on accurate verbal descriptions of (i.e., guesses about) the key-press sequences critical for reinforcement in the first task. Subjects alternated between these two tasks in cycles. Each cycle lasted approximately ten minutes. Subjects worked for five minutes plus the time necessary to complete any ongoing sequence on the key- pressing task, then a maximum of five minutes on the guessing task. Points displayed on the monitor were cumulative for only that cycle's key-pressing. Cycles followed one another with the same order of events throughout each session. As many cycles as possible were completed within each session.

General experimental instructions were delivered as the very first step of a subject's participation, prior to the first key-press/guess cycle. Instructions described the project as a learning experiment and identified the subject's job as earning points. (Method of payment and extra credit points were specified on a separate consent form.) The two methods of earning points were then described. A complete copy of the instructions is provided in the Appendix. Subjects were given a copy to read as the experimenter read instructions aloud. A copy remained beside each subject's keyboard for the duration of the experiment.

### Key presses

Reinforcement criteria for key-press sequences were based on the pattern by which the filled square progressed through the stimulus grid. The arrangement constitutes an operant "problem-solving" task similar to that used by Schwartz (e.g., 1982). This procedure was chosen for several reasons. First, it had already been proven sensitive to the effects of instructional variables (Schwartz, 1982). Second, it allowed a potentially infinite number of different reinforcement criteria, or problems, to be programmed (e.g., the filled square must pass through a specific grid position to earn a point, or the filled square must move up at least once, etc.). Thus, a number of opportunities for assessing instruction effects could be arranged for each subject (as opposed to measuring the impact of a single rule throughout a subject's participation).Third, this task allowed repeated measures of response acquisition, an aspect of behavior particularly targeted by instructional use (e.g., Skinner, 1963).

In Experiment I, subjects were presented with a series of different problems (or reinforcement contingencies) throughout their participation. One problem was in effect at a time and a subject responded on that contingency for either ten cycles or until the acquisition of reliable and consistent point production had been demonstrated in each of at least two cycles.

Change from one problem to another was unsignalled and occurred approximately halfway through a key-pressing cycle. Thus, discrimination of a change in problems had to be based on contact with contingency changes.

The reinforcement criteria for each problem are listed in Table 1. For each problem any number of different response sequences could earn points as long as the critical reinforcement criterion was satisfied. Thus, portions of the sequence irrelevant to the criterion were free to vary. The first problem presented was for practice purposes, to familiarize the subject with the experimental procedures. Thereafter, problems were designed in matching pairs. Each member of a problem pair imposed a reinforcement criteria that was the mirror image of its pair-mate's, given the symmetry of the 5 x 5 grid. For example, requiring that a sequence begin with two moves to the left has exactly the same relation to reaching the goal position as requiring that the first two moves be in a downward direction. This symmetrical contingency design was employed in order to match problems (as much as possible) on all variables that could be related to problem "difficulty" (i.e., various measures of response cost such as the number of responses necessary to reach the goal position, the number of switches required from one key to another, the nature of the sequence needed to make contact with the reinforcement contingency, etc.). Matching problem pairs in this way allowed each pattern contingency to be presented as two different problems without repeating exactly the same reinforcement requirement. Table 1 also gives the order of problem presentation. As indicated, presentation of matching pair members was always separated by at least two other problems. Each subject was exposed to as many problems as possible during their twenty hours of participation.

In addition to the pattern contingency, each problem imposed an IRT > t schedule on responding. That is, the interval between any two key-press responses had to meet or exceed the specific t value in order for the latter response to be effective in changing the position of the filled square on the grid. Both members of a problem pair imposed the same t value, while each different problem pair imposed a different t value. The relation of a problem's t value to that of the preceeding problem (i.e., shorter than or longer than) was the same for both problem members. The t values for each problem are given in Table 1. This schedule requirement provided still another measure of sensitivity, in addition to the acquisition of successful response sequences.

## Guesses

At the conclusion of each five minute key-pressing period, subjects immediately began the guessing portion of the cycle. At this time, subjects were given guess sheets that provided space for five responses to the statement, "In order to earn points on the computer. . . ." After a maximum of five minutes, subjects turned their guess sheets in to the experimenter who indicated the number of points earned by each guess (from 0 to 3) and returned the sheet to the subject. Points earned by guessing were not included in the count displayed on the monitor. The next key pressing period began when the subject returned his or her scored guess sheet to the experimenter.

For each problem presented, a subject's responses on the guess sheet were either shaped or instructed. Procedures used for these purposes were as similar as possible to those described by Catania et al. (1982), Shimoff et al. (1985), and Matthews et al. (1986).

Shaped guesses. For problems with shaped verbal responses, guesses resulted in differential point delivery based on their correspondence to specific criteria. No points were awarded for guesses that stated specific sequences of key presses (i.e., move down, then left, then down, etc.). Rather, in order to earn points guesses had to identify the particular pattern elements that were critical to reinforcement (e.g., the first two responses or moving to the right). Pilot work had shown that when statements of specific sequences earned even partial credit, guesses would often not change from a report of the nonverbal behavior that was reinforced. In such cases, the opportunity for any shaping beyond that provided by nonverbal contingencies was lost.

While point delivery had to be somewhat individualized to each subject's actual guesses, there were specific criteria for the type of verbal statements that would earn 1, 2, or 3 points for each problem. The criteria were determined by the instruction delivered to the matched pair member. Any guess including each of the pattern components that were instructed for the matched pair member earned three points. Guesses that included only some of those components earned one and one half points, and guesses that included none of those components earned zero points. Adherence to these criteria allowed for maximum standarization of shaping procedures. The only variations from these criteria involved assignment of an extra half point for statements that did not meet the criteria specified for a given point level but nevertheless a) showed progress from the previous level, b) showed a change from an unsuccessful train of guessing, or c) met the criteria but included unnecessary pattern components.

Instructed guesses. For problems with instructed guesses, subjects were given a notecard with an instruction specific to that problem printed on it. The notecard was delivered at the very start (i.e., just prior to the key pressing component) of the first full cycle of that problem's presentation. Thus, each problem had a one cycle transition period prior to any instruction delivery. Once delivered, a notecard remained on the table beside a subject's terminal for the duration of her or his exposure to that problem. It was removed when the next problem in the series was put into effect, just prior to its first full cycle.

The instructions presented were never complete specifications of the reinforcement requirements. Rather, they provided considerable restrictions on the vast range of possibilities by instructing subjects to guess about particular responses in the sequence, general patterns, or directions of movement. The problems that were instructed and the instructions that were delivered for each are presented in Table 2. Instructions were designed to increase the probability that responding would contact reinforcment contingencies more quickly, while still requiring sensitivity to those contingencies for successful performance. Therefore, guesses that provided more detail than instructions, even if accurate, earned no additional points. In this way only contact with the actual contingencies could be responsible for successful key-pressing performance.

Points were awarded to instructed guesses contingent on their correspondence to the instruction. The criteria for awarding points were the same for all instructed guesses. Guesses that included or restated each of the pattern components specified by the instruction earned the maximum of three points. Descriptions that were more explicit than the instruction earned no more points than instruction restatement. Any guess that included part but not all of the instructed components earned one and one half points. A guess that failed to include any instructed component earned no points.

Table 1: Problem Pairs - Experiment I

| Problem | Reinforcement Criteria | Presentation Order | t value |
|---|---|---|---|
| Practice | left and down responses must alternate | 1st | |
| Pair 1 | a) first two moves must be made on the left key | 2nd | 2 seconds |
| | b) first two moves must be made on the down key | 7th | |
| Pair 2 | a) must hit each position adjacent to the bottom, right corner | 3rd | .75 seconds |
| | b) must hit each position adjacent to the top, left corner | 6th | |
| Pair 3 | a) responses 1 and 2 must be different; responses 2 and 3 the same | 4th | 1.75 seconds |
| | b) responses 1 and 2 must be the same; response 3 different | 11th | |
| Pair 4 | a) at least two responses must be made on the up key | 5th | 1 second |
| | b) at least two responses must be made on the right key | 9th | |
| Pair 5 | a) must hit each position adjacent to the start | 8th | 1.5 seconds |
| | b) must hit each position adjacent to the goal | 12th | |
| Pair 6 | a) must hit each position in one column | 10th | 1.25 seconds |
| | b) must hit each position in one row | 13th | |

Table 2: Instructions - Experiment I

| Problem | Instruction |
|---|---|
| A1 | You should guess about your first two moves. |
| B2 | You should guess about forming a square. |
| C2 | You should guess about your first three responses. |
| D1 | You shoud guess about the up key. |
| E1 | You should guess about the goal position. |
| F2 | You should guess about one row. |

Order of Instruction (I) and Shaping (S) Conditions

1st problem - S
2nd problem - I
3rd problem - S
4th problem - S
5th problem - I
6th problem - I
7th problem - S
8th problem - S
9th problem - S
10th problem - S
11th problem - I
12th problem - S
13th problem - I

For each problem pair, one member had guesses shaped and the other member had guesses instructed. Given the matched problem contingency, the reasoning was that consistent performance variations across pair members could be attributed to the influence of instructions versus shaping. If instructions affect sensitivity differently than does shaping, these effects should be reflected in performances on the same reinforcement contingencies.

The first pair member (i.e., the instructed or the shaped) to be presented was counterbalanced aross problem pairs. The order of presentation was also varied so that no more that two instructed or shaped problems were presented in succession. The exact order of problem presentation is presented in Table 2.

## Results

Figures 1 through 5 show the point data for subjects 1 through 5 respectively. The first set of axes on each figure shows data from key-pressing performances. Each data point represents the number of points earned for each cycle divided by the number of sequences completed. The second set of axes shows the total number of points earned by guessing for each cycle. The third set of axes shows the highest number of points earned by any single guess of a cycle and the number of guesses actually made for that cycle. The figures are organized such that instructed and shaped performances for each problem pair are presented together; in this way any effects of instructing versus shaping may be directly compared. Data are shown for those problems on which subjects received exposure to both the instructed and shaped versions. Subjects 1 and 2 completed problem pairs A, B, and D; subject 3 completed A, B, C, and D; subjects 4 and 5 completed A, B, C, D, and E.

### Computer Points

Acquisition of effective (i.e., point-earning) response sequences was evident for both the instructed and shaped versions of each problem for all five subjects. Thus, key-pressing performances gave all indications of being sensitive to sequence contingencies under both conditions. A more specific comparison of shaped and instructed performances revealed the following relations.

Subject #1 showed increasingly effective point sequences during both shaped and instructed problems. (See Figure 1.) In each of the three problem comparisons however, point-earning sequences increased more rapidly and to higher levels when instructions were presented than when guesses were shaped in the absence of instructional stimuli.

Subject #2 also revealed sensitivity to sequence contingencies in the presence of both instructed and shaped performances. (See Figure 2.) However, the pattern of acquisition was somewhat different from that revealed by subject #1. For subject #2 point-earnings increased more quickly in the presence of the instructed version of two out of three problems (i.e., problems A and B). The total number of points earned was also higher in the instructed version of problem B, and while the shaped version of problem A reached higher point levels ultimately, this occurred only with exposure to the problem contingency beyond that contacted during the instructed version. In contrast to problems A and B, point earnings increased quickly and to a much higher level during the shaped version of problem D than during its instructed counterpart.

Subject #3 showed more rapid increases in computer-earned points during the instructed versions of all four problems. (See Figure 3.) Responding during the shaped versions of these problems also appeared very sensitive to contingencies in at least three of four problems (B, C, and D). (Points for sequences showed little increase with continued exposure to sequence contingencies in the shaped version of problem A. Given that this was the first problem to follow practice trials for this subject, the possibility exists that the practice provided had been insufficient to allow adequate contact with and adjustment to task requirements. Although point increases did occur during practice, they were not substantial.) With exposure beyond that provided for the instructed version, total points reached somewhat higher levels during the shaped version of problem B. Approximately equivalent point levels were attained for the shaped and instructed versions of problems A, C, and D.

Subject #4 also revealed sensitive acquisition of effective response sequences in both the shaped and instructed versions of all five problems contacted. (See Figure 4.) Point earnings increased somewhat more quickly during the instructed versions of problems B and C, but increased more quickly during the shaped versions of problems A and D. Point increases were equivalent for the two versions of problem E. Total point levels attained were similar for both versions of problems B and C, and were higher for the shaped versions of problems A, D, and E (although the higher levels in E occurred only with additional contingency exposure compared to that provided during the instructed version).

Consistent with each of the other subjects, #5 also showed sensitive acquisition on both versions of all five problems. (See Figure 5.) Point increases were somewhat more rapid in the instructed version of problem D, and during the shaped versions of A and B. Rates of increase were very similar across the two versions of C and E. Overall levels attained were approximately equal for the two versions of C and D, but somewhat higher for the shaped version of A, B, and E (E only with additional shaped exposure).

In summary, no consistent sensitivity effect as a function of instruction versus shaping was established for any subject. Similarly, an analysis across subjects for each problem pair also failed to reveal an imbalance in the sensitivity demonstrated during instructed and shaped problem versions. For problem pair A, two subjects (#4 and #5) showed more rapid increases and attained higher levels during the shaped problem versions. In contrast, subjects #1, 2, and 3 showed more rapid increases during the instructed problem version. Subject #1 also attained higher point levels during the instructed version, while #2 eventually reached higher levels during the shaped problem, but only after additional exposure. Only subject #3 failed to show sensitive increases in both problem versions, perhaps for the reasons commented on previously.

In problem pair B, three subjects (#1, 2, and 4) increased points more quickly and to at least a somewhat higher level during the instructed version. A fourth subject (#3) increased point earnings at very similar rates for the two versions and reached a higher level with additional exposure to the shaped version. Finally, subject #5 increased both more quickly and to a higher level with the shaped problem.

Problem pair C was similarly mixed. Only subject #3 showed much variance across the two problem versions, with more rapid point increases following instructions. Highest point levels attained were similar in both versions for all three subjects (3, 4, and 5). The extent of contingency exposure prior to reaching those levels was also very similar for subjects 4 and 5.

For problem pair D, point increases were more rapid and reached higher levels for two subjects (#2 and 4) during the shaped version. The remaining three subjects (#1, 3, and 5) revealed quicker point increases during the instructed version, and subjects 1 and 3 also attained higher point totals during that version. Point totals for subject #5 were very similar across the two versions.

Both subjects exposed to problem pair E showed similar rates of acquisition across the two problem versions. Highest level of points were attained by both during the shaped problem version, but in both cases these higher levels occurred with exposure beyond that provided during the instructed version.

In summary, sensitivity to contingencies for key-press sequences was demonstrated in the presence of both instructed and shaped members of each problem pair. As judged by the total number of points earned per cycle and the extent of contingency exposure necessary to shape effective performance, there was no evidence for any systematic benefit provided by either instructions or additional shaping contingencies. Neither was there any evidence of an interference or deficit that could be attributed to either of these two variables.

### Points for Guesses

The number of points earned by verbal responses revealed relations similar to those just described for points earned by key-pressing. Sensitivity to the contingencies for guessing was demonstrated during both instructed and shaped problem versions. In contrast to the nonverbal responding however, results for guessing did reveal an advantage for instructed as compared to shaped responding. In general, the points earned in the presence of instructional stimuli tended to increase more quickly and to a higher level than when guesses were shaped.

Subject 1, for example, showed rapid acquisition of guesses that earned the maximum number of points per cycle during the instructed version of all three problems contacted. (See Figure 1.) Thus, instructed guesses seemed to show great contingency-sensitivity. The sensitivity of shaped guesses was somewhat different. The total number of points earned per cycle never showed an orderly pattern of acquisition for any of the three problems. Although the points earned increased greatly for some cycles, subsequent cycles sometimes returned to previous point levels. However, the acquisition pattern looked much more orderly when the highest number of points earned by any single quess was considered. For this measure, sensitivity was demonstrated by steady increases in point earnings with continued exposure to guess-shaping contingencies. As indicated on Figure 1, although individual guesses were shaped into effective ones, the number of guesses made on any particular cycle were often less that the number allowed; consequently, the total points earned were less than maximum. This pattern of guessing might be described as showing a lack of sensitivity because the subject did not maximize earnings even when particular guesses were effective. Another possibility is that the functional reinforcer was not the number of points earned but instead, actually producing the problem solution. The single most effective guesses did show acquisition patterns while redundant guesses, consequated only by additional point accrual, did not. Instructed guessing did seem to maximize point earnings, however.

The guessing data for subject #2 were very similar to those of subject #1. Instructed guesses earned the maximum points available in very little time. The increases in total points earned per cycle mirrored the increases for the most points earned for any single guess, and the maximum of five guesses were made on almost every cycle. For shaped guesses, the points earned by any single guess also revealed acquisition although the development was slower and more irregular than for instructed guesses. Total points earned reflected the increases in single guess effectiveness in only one of the three problem pairs (problem D). During the other two problems fewer than five guesses were made on many of the cycles. Once again then, instructed performance seemed quite sensitive, and while shaped performances also appeared sensitive on one measure (points/guess), the sensitivity shown in total points earned was more ambiguous.

Sensitivity seemed more apparent throughout all aspects of subject #3's guessing performance. As with subjects 1 and 2, the instructed guesses of #3 quickly attained maximum levels for points per guess and for total points per cycle. Five guesses were attempted on all but three instructed cycles for problem C. Unlike the patterns shown by subjects 1 and 2, total points earned on shaped problems reflected very closely the increases shown in points earned per guess (somewhat less closely for problem A than for the other three). A majority though still not all opportunities to guess resulted in five attempts.

The guessing data of subject 4 were similar to those of subject 3 in many respects. Instructions for guessing reliably led to the maximum number of points per guess and per cycle. Because five guesses were made consistently, the patterns of total point acquisition followed those for single guesses very closely, a characteristic that was also true of shaped guessing. Thus, shaped performances appeared sensitive to point contingencies on each measure. In fact, subject 4 gave some evidence of superior acquisition in the presence of the shaped versus the instructed problem version. (Subject #4 was the only one to show such a pattern.) In problem C, guessing reached maximum levels more quickly when shaped, and initial increases were more rapid during the shaped versions of problems A and D although higher point levels were eventually achieved for both during the instructed problem version. Thus, sensitivity was revealed in both versions of each problem. Even when acquisition was more rapid in one version it would be inaccurate to characterize performance in the other as insensitive.

Subject 5 showed a guessing pattern similar to that described for subject 1 and 2. Instructed guesses quickly attained maximum point-earning levels in four of the five problems. The pattern shown in problem A was unusual for instructed performances. The acquisition of total points per cycle did not follow that for points per guess and guess content changed even after the maximum points for a single guess had been attained. It seems posssible that this pattern was reflective of inexperience with instructed problem versions. The instructed version of problem A was the first one contacted, and the patterns shown in subsequent instructed versions were more typical for that subject as well as the others. Typical acquisition curves were also characteristic of shaped guessing for subject 5 as measured by the points earned per single guess. However, the total points earned per cycle did not always reflect the effectiveness of single guesses. Thus, while points per guess seemed to demonstrate contingency sensitivity, total points earned by guessing did so to a much lesser extent. Furthermore, the number of guesses attempted per cycle was often less than five for shaped problem versions while five guesses per opportunity was the norm for instructed versions (excluding problem A).

### Inter-response time data

The IRT relative frequency distributions for subjects 1 through 5 are presented in Figures 6 through 10 respectively. Table 3 presents the mean IRT value and the total number of IRTs for each problem version for each subject.

For subject #1 the percentages of IRTs that were shorter than the t value were larger during the shaped version of all three problems contacted. (See Figure 6.) In other words, a higher percentage of ineffective responses occurred during the shaped problem versions. For problem A the distribution of IRTs greater than the t value also revealed a larger percentage of responses closer to the t value during the instructed problem version. Mean IRT values also documented this difference, with the mean for instructed problem IRTs much closer to the actual t value than that for shaped problem IRTs. In problems B and D however, a higher percentage of shaped problem IRTs were closer to the t value. Mean IRT values were closer to the t value for the shaped versions of these two problems for this subject. Sensitive IRT responding was evidenced in both versions of each problem. While fewer ineffective responses (i.e., IRTs<t) were made during instructed problem versions, no consistencies in greater sensitivity for IRTs > t were shown for either problem version.

For subject #2, a programming error involving the IRT value for the instructed version of problem B resulted in different t values during the two versions of the problem. Therefore, the IRT distribution comparison is not presented for that problem. With respect to IRTs < t, the percentages of responses were quite similar across versions of problems A and D. (See Figure 7.) Ineffective IRTs were slightly greater during the shaped version of problem A, and they were somewhat higher during the instructed version of problem B. However, for IRTs > t responses from the shaped problem version fell closer to the t value than did instruction version IRTs for both problems A and D. The mean IRT values for each problem version also reflect this relation. For this subject no difference in sensitivity to the IRT contingency was apparent for IRTs < t , while responses longer than the t value gave some indication of greater sensitivity during the shaped problem version.

The IRT data for subject #3 allowed distribution comparisons for four problems. (See Figure 8.) With respect to IRTs < t problems A, B, and C all revealed more ineffective responses during the instructed problem version, although the discrepancies were small. In contrast, the shaped version of problem D had the higher percentages of ineffective responses, and the discrepancy between the two problem versions was greater than that of the other three problems. Problem D also had the largest discrepancy in the distributions of IRTs > t. For these responses, the shaped problem version resulted in significantly more responses falling closer to the t value. The distributions of problems A and B also showed this relation although to a relatively lesser extent, while for problem C responses were somewhat closer to the t value in the instructed version. Mean IRT values also support these descriptions. Thus, the relative sensitivity shown during shaped and instructed problem versions for subject 3 varied from one problem to the next. Overall, sensitivity to the IRT contingency appeared good in both versions of all four problems.

Subject 4 showed a pattern similar to that of subject 1 and 3 in that there was no consistent pattern of relative sensitivity for instructed and shaped problem versions. (See Figure 9.) More responses shorter than the t value occurred during the instructed version of problems A, B, D, and E although the discrepancies between versions for D and E were minor. The distribution for the shaped version of problem C contained the higher percentage of ineffective responses. When considering responses longer than the t value a higher percentage of IRTs fell closer to that t in the shaped version of problems A, C, and D while the t value was approximated more closely in the instructed versions of problems B and E. Mean IRT values also show this relation. The actual discrepancies in the distributions were minimal for problems B, C, and D; somewhat more substantial for problem E, and finally, for problem A the two patterns shown were very dissimilar. In fact, the distribution for the instructed version of problem A contained a higher percentage of ineffective responses than any version of any problem for any subject. Indeed, this was the only case in which the mean IRT for a problem distribution was less than the t value. It seems important to note that the instructed version of problem A was the first problem contacted after the practice problem, and thus was the first to impose an IRT contingency. While this fact may help to account for the relatively higher percentage of short responses on this problem, it is still unclear why this subject and no other exhibited this degree of insensitivity. Other than this particular problem, the overall sensitivity demonstrated by subject 4's IRT distribution was good, and well within the range shown by the other subjects.

With respect to IRT performance subject 5 consistently exhibited the most sensitive performance of the five subjects.

(See Figure 10.) He also exhibited the same lack of consistency in relative sensitivity described above. The percentage of ineffective responses was greatest during the instructed versions of problems A, B, and D, although the discrepancy across the two versions of D was very small. For problems C and E, the percentage of short responses was somewhat larger during the shaped problem version, though once again the differences were minimal. More of the responses that exceeded t fell closer to the t value during the shaped version of problems A and D, and during the instructed version of problems B, C, and E. Again, this characterization of visual inspection was supported by the mean IRT value of each problem version.

In summary, 19 different comparisons were made between the IRT distributions of shaped and instructed problem versions. No consistencies in relative sensitivity under these conditions were revealed. The difference between the t value and a problem's mean IRT serves as one index of IRT sensitivity. By this index, IRT performance was more sensitive during the shaped problem version in 12 comparisons and during the instructed version on seven comparisons. For 11 comparisons, mean IRT values for the two problem versions differed by less than one tenth of a second. (Five of these comparisons with minimal differences were described previously as showing greater sensitivity in the shaped version while six were described as showing greater instructed problem sensitivity. Thus, it could be pointed out that when discrepancies were larger than one

Figure 1. Number of points earned by Subject 1 during each cycle of each problem. The top panel shows the total number of points earned on the computer task. The middle panel shows the total number of points earned on the guessing task. The bottom panel shows the highest number of points earned by a single guess and the number of guesses that were made. Filled data points represent performances when guesses were shaped. Open data points represent performances when guesses were instructed.

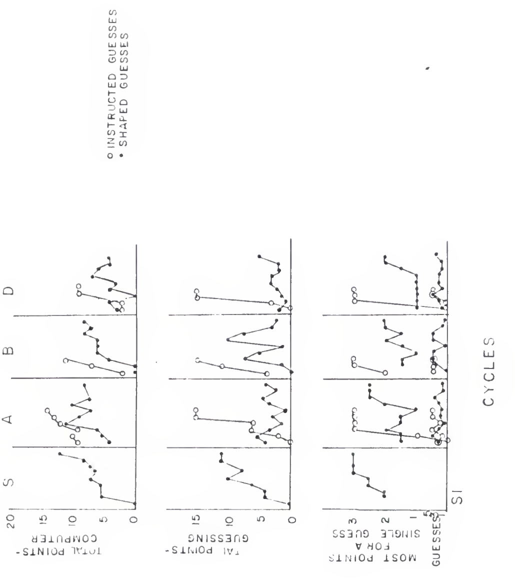

○ INSTRUCTED GUESSES
• SHAPED GUESSES
S
A
B
D
TOTAL POINTS-COMPUTER
20
15
10
5
0
TAI POINTS-GUESSING
15
10
5
0
MOST POINTS FOR A SINGLE GUESS
3
2
1
GUESSES
5
3
1
SI
CYCLES

Figure 2. Number of points earned by Subject 2 during each cycle of each problem. The top panel shows the total number of points earned on the computer task. The middle panel shows the total number of points earned on the guessing task. The bottom panel shows the highest number of points earned by a single guess and the number of guesses that were made. Filled data points represent performances when guesses were shaped. Open data points represent performances when guesses were instructed.

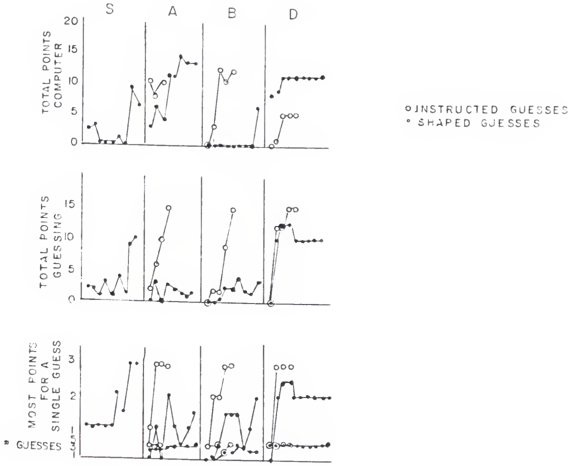

S
A
B
D
TOTAL POINTS COMPUTER
20
15
10
5
0
TOTAL POINTS GUESSING
15
10
5
0
MOST POINTS FOR A SINGLE GUESS
3
2
1
* GUESSES
○ INSTRUCTED GUESSES
• SHAPED GUESSES

Figure 4. Number of points earned by Subject 4 during each cycle of each problem. The top panel shows the total number of points earned on the computer task. The middle panel shows the total number of points earned on the guessing task. The bottom panel shows the highest number of points earned by a single guess and the number of guesses that were made. Filled data points represent performances when guesses were shaped. Open data points represent performances when guesses were instructed.

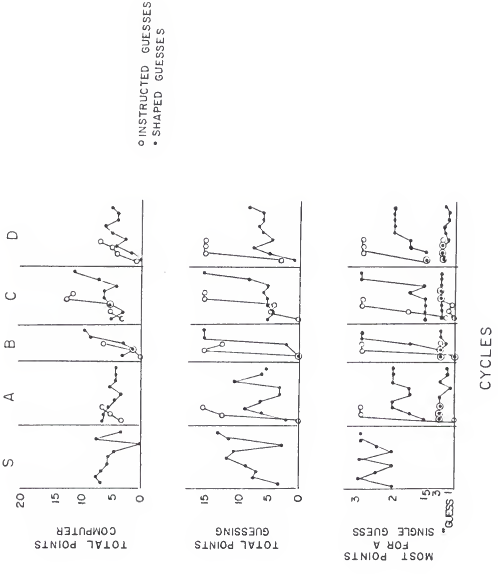

○ INSTRUCTED GUESSES
• SHAPED GUESSES
S
A
B
C
D
TOTAL POINTS COMPUTER
20
15
10
5
0
TOTAL POINTS GUESSING
15
10
5
0
MOST POINTS FOR A SINGLE GUESS
3
2
15
3
1
* GUESS
CYCLES

Figure 3. Number of points earned by Subject 3 during each cycle of each problem. The top panel shows the total number of points earned on the computer task. The middle panel shows the total number of points earned on the guessing task. The bottom panel shows the highest number of points earned by a single guess and the number of guesses that were made. Filled data points represent performances when guesses were shaped. Open data points represent performances when guesses were instructed.

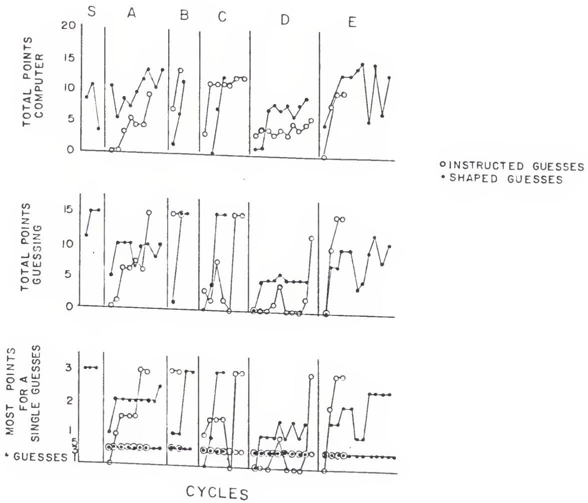

S
A
B
C
D
E
TOTAL POINTS COMPUTER
20
15
10
5
0
TOTAL POINTS GUESSING
15
10
5
0
MOST POINTS FOR A SINGLE GUESSES
3
2
1
5
3
• GUESSES 1
CYCLES
○ INSTRUCTED GUESSES
• SHAPED GUESSES

Figure 5. Number of points earned by Subject 5 during each cycle of each problem. The top panel shows the total number of points earned on the computer task. The middle panel shows the total number of points earned on the guessing task. The bottom panel shows the highest number of points earned by a single guess and the number of guesses that were made. Filled data points represent performances when guesses were shaped. Open data points represent performances when guesses were instructed.

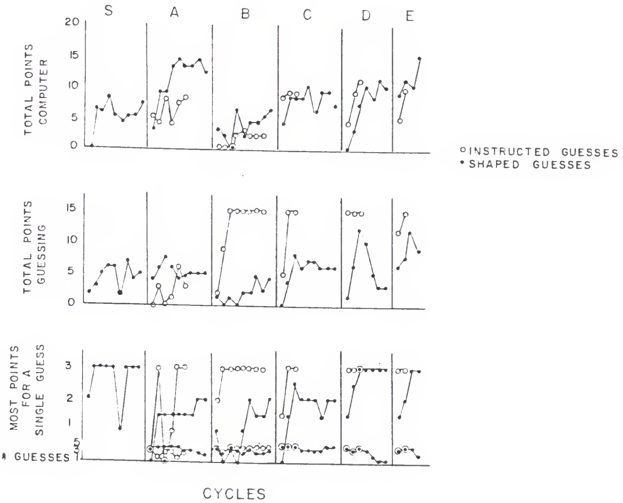

S
A
B
C
D
E
TOTAL POINTS COMPUTER
20
15
10
5
0
TOTAL POINTS GUESSING
15
10
5
0
MOST POINTS FOR A SINGLE GUESS
3
2
1
5
3
# GUESSES 1
CYCLES
○ INSTRUCTED GUESSES
• SHAPED GUESSES

Figure 6. IRT distribution for Subject 1. Each data point represents the percentage of IRTs falling within each 1/10 second interval. T values are represented by broken vertical lines. Filled data points represent performances when guesses were shaped. Open data points represent performances when guesses were instructed.

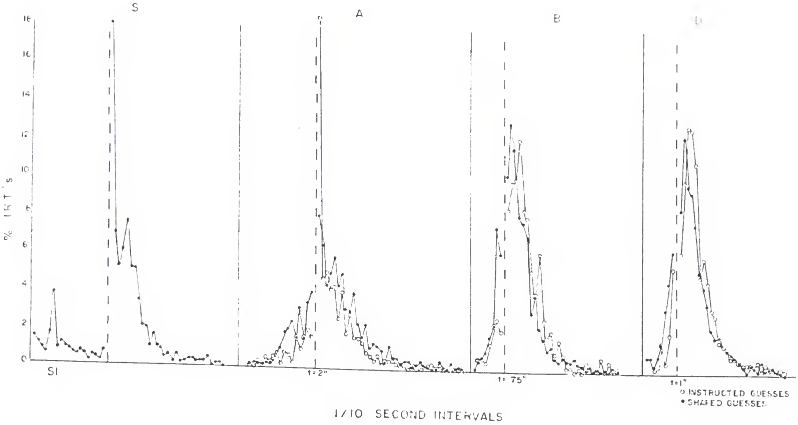

S
A
B
C
18
16
14
12
10
8
6
4
2
0
% IRT's
SI
t=2"
t=.75"
t=1"
○ INSTRUCTED GUESSES
● SHAPED GUESSES
1/10 SECOND INTERVALS

Figure 7. IRT distribution for Subject 2. Each data point represents the percentage of IRTs falling within each 1/10 second interval. T values are represented by broken vertical lines. Filled data points represent performances when guesses were shaped. Open data points represent performances when guesses were instructed.

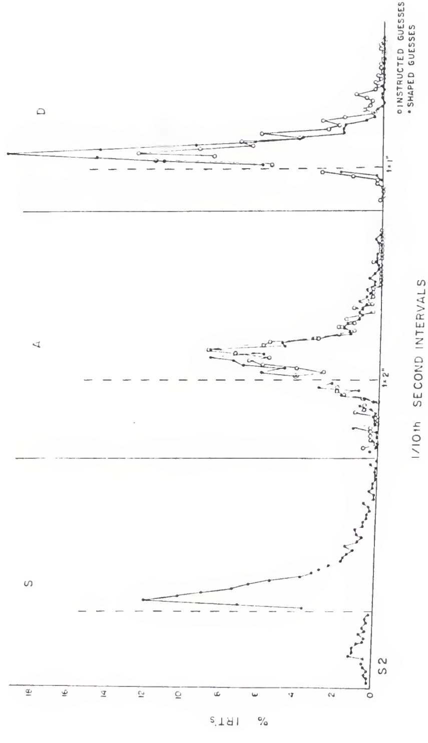

% IRT's
0
2
4
6
8
10
12
14
16
18
S2
S
A
D
1=2"
1=1"
1/10th SECOND INTERVALS
○ INSTRUCTED GUESSES
• SHAPED GUESSES

Figure 8. IRT distribution for Subject 3. Each data point represents the percentage of IRTs falling within each 1/10 second interval. T values are represented by broken vertical lines. Filled data points represent performances when guesses were shaped. Open data points represent performances when guesses were instructed.

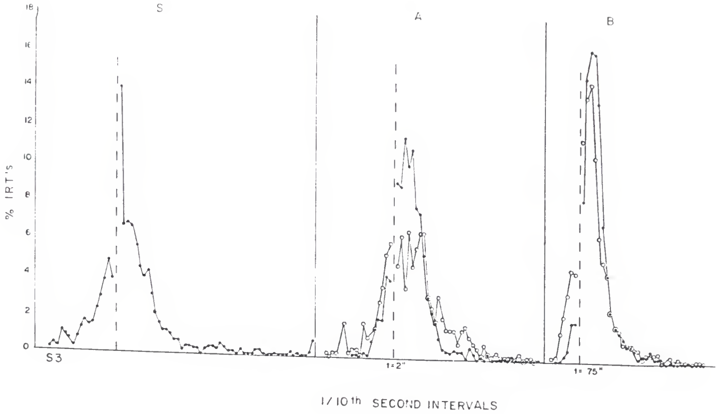

S
A
B
18
16
14
12
10
8
6
4
2
0
% IRT's
S3
1=2"
1= 75"
1/10th SECOND INTERVALS

Figure 9. IRT distribution for Subject 4. Each data point represents the percentage of IRTs falling within each 1/10 second interval. T values are represented by broken vertical lines. Filled data points represent performances when guesses were shaped. Open data points represent performances when guesses were instructed.

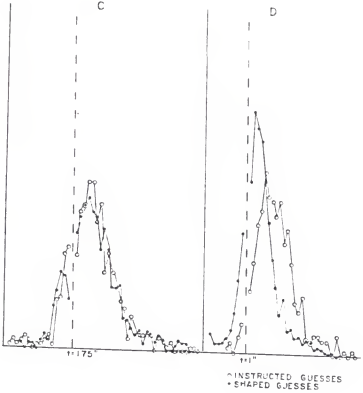
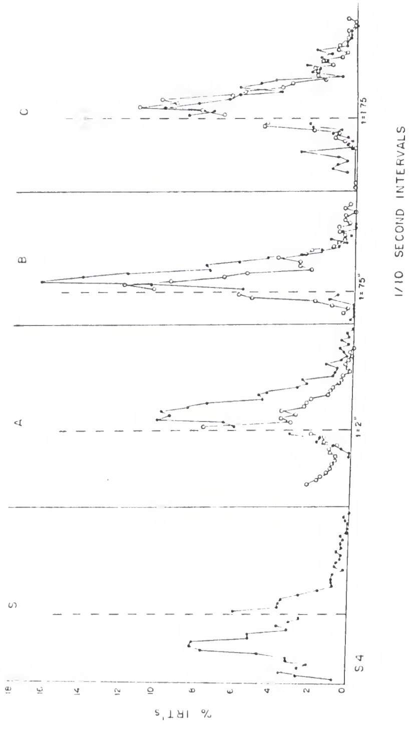


Figure 8 - - Continued


S 4
S
A
B
C
1=2"
1=75"
1=175
1/10 SECOND INTERVALS
% IRT's
0
2
4
6
8
10
12
14
16
18

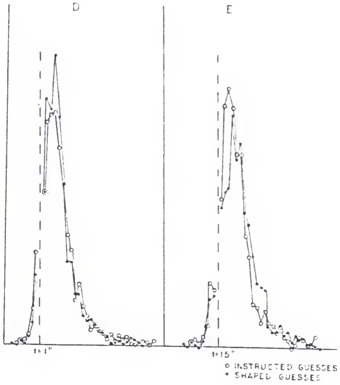
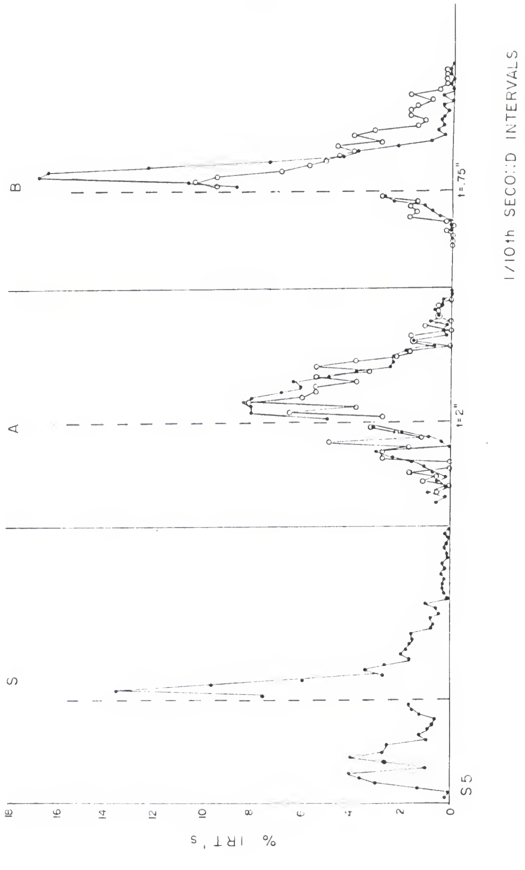


Figure 9 - - Continued

Figure 10. IRT distribution for Subject 5. Each data point represents the percentage of IRTs falling within each 1/10 second interval. T values are represented by broken vertical lines. Filled data points represent performances when guesses were shaped. Open data points represent performances when guesses were instructed.


S5
S
A
B
t=2"
t=.75"
18
16
14
12
10
8
6
4
2
0
% IRT's
1/10th SECOND INTERVALS

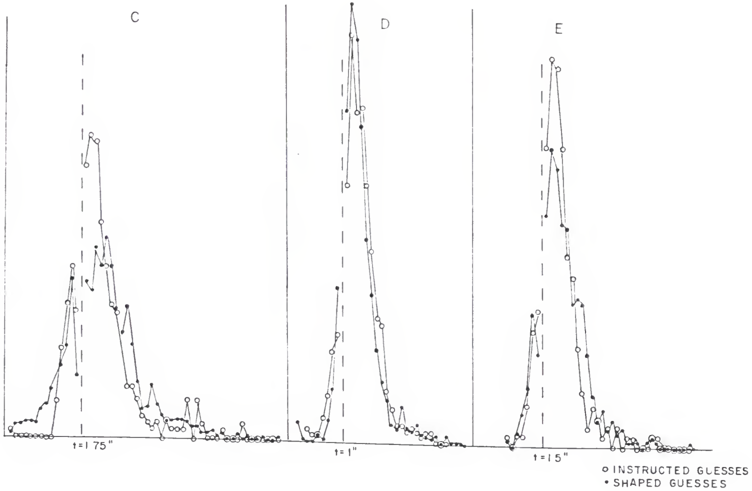


Figure 10 - - Continued

Table 3: Inter-response Time Means in Tics for Instructed (I) and Shaped (S) Problem Conditions

| | Problem A | | Problem B | | Problem C | | Problem D | | Problem E | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (t = 120 tics) | | (t = 45 tics) | | (t = 105 tics) | | (t = 60 tics) | | (t = 75 tics) | |
| | I | S | I | S | I | S | I | S | I | S |
| Subjects | | | | | | | | | | |
| S1 | | | | | | | | | | |
| N | 919.0 | 934.0 | 434.0 | 1301.0 | - | - | 584.0 | 1279.0 | - | - |
| Mean | 136.2 | 145.7 | 73.0 | 66.0 | - | - | 89.6 | 82.4 | - | - |
| S2 | | | | | | | | | | |
| N | 278.0 | 877.0 | 76.0 | 1378.0 | - | - | 684.0 | 1140.0 | - | - |
| Mean | 161.2 | 158.9 | -- | -- | - | - | 94.2 | 85.3 | - | - |
| S3 | | | | | | | | | | |
| N | 185.0 | 613.0 | 345.0 | 811.0 | 526.0 | 809.0 | 400.0 | 1347.0 | - | - |
| Mean | 151.2 | 145.6 | 77.7 | 68.8 | 133.9 | 136.7 | 108.0 | 81.1 | - | - |
| S4 | | | | | | | | | | |
| N | 1568.0 | 877.0 | 349.0 | 460.0 | 757.0 | 371.0 | 1279.0 | 1249.0 | 527.0 | 1238.0 |
| Mean | 68.1 | 154.9 | 70.1 | 71.9 | 134.8 | 131.0 | 89.2 | 86.9 | 102.5 | 107.7 |
| S5 | | | | | | | | | | |
| N | 515.0 | 1059.0 | 1569.0 | 1517.0 | 335.0 | 1034.0 | 442.0 | 1064.0 | 247.0 | 531.0 |
| Mean | 151.0 | 143.4 | 68.0 | 69.2 | 126.6 | 130.6 | 79.7 | 79.1 | 94.2 | 97.1 |

*Note*. One tic = 1/60th of a second.

*Note*. - indicates that problem was not presented. -- indicates that data were lost.

tenth of a second, responding seemed more sensitive during the shaped problem version in seven out of eight cases. It might even be argued that this indicates a tendency toward greater sensitivity in shaped problem versions. However, the most descriptive characterization of these IRT data is that sensitivity was high in both problem versions and in most cases there was very little difference in the distributions of the two problem versions.

## Discussion

The present research was designed to examine and compare the effects of shaping and instructing a subject's verbal behavior. More specifically, the effects of shaping and instructing were investigated on both the verbal responses that were directly shaped or instructed and on the associated nonverbal responding. In similar investigations, Catania et al. (1982) and Matthews et al. (1985) reported that the way in which a subject's verbal responses were established determined the sensitivity of subsequent nonverbal performance to reinforcement contingencies. Shimoff et al. (1986) went further to report that any verbal behavior associated with responding would result in insensitive performances. These findings were not reproduced. Instead, Experiment I repeatedly demonstrated sensitive acquisition of complex response sequences both when guesses had been shaped and when they had been instructed. There was no evidence that sequences were more or less likely to change with their consequences as a function of the guess condition, and this was true for both the rate and the extent of acquisition. Furthermore, a fine-grained inter-response time analysis of these same sequences failed to reveal any indication of insensitivity to temporal contingencies. By all measures, then, nonverbal performances seemed sensitive to the demands of the experimental contingencies, regardless of how verbal behavior was established.

It is interesting to consider the variables that may be responsible for the differences in these sets of results. First, Catania et al., Matthews et al., and Shimoff et al. based their reports on the differences between the performances of subjects whose verbal responses were instructed and those of other subjects whose verbal responses were shaped. In contrast, Experiment I compared the same subject's performances in the presence of different conditions. Experiment I also continued contingency exposure under both conditions until there was evidence of adjustment to the contingencies. In a number of comparisons even sequences that were acquired slowly proved to reach effectiveness levels equal to or better than those that developed more quickly, a pattern that would not have been evident had exposure been cut short. In the other studies (Catania et al., 1982, Matthews et al., 1985, and Shimoff et al., 1986), subjects were not always provided with enough exposure to induce the acquisition of sensitive response patterning.

Another contrast between the investigations concerned the accuracy of the instructional stimuli. Subjects in the earlier studies (Catania et al., 1982; Matthews et al., 1985; Shimoff et al., 1986) were sometimes provided with inaccurate instructions or had their verbal response shaped in a direction that was incongruent with reinforcement requirements. This was not done in Experiment I. Instructions and criteria for reinforcement for guessing always matched the contingencies in effect for key-pressing responses.

A final and, perhaps, the major distinguishing characteristic for the investigations being considered concerned the differential patterns of reinforcement available for sensitive (i.e., those that changed with contingencies) and insensitive (i.e., those that did not change with contingencies) performances. Subjects in each of the earlier investigations (Catania et al., 1982; Matthews et al., 1985; Shimoff et al., 1986) responded on a multiple random ratio 20 random interval 10 second schedule. While response rates that closely matched schedule parameters earned maximum reinforcement rates with minimum response cost, response rates that were completely insensitive to schedule parameters also netted considerable reinforcement. In other words, insensitive performances would be maintained, and sensitive performances were not required for reinforcement.

In contrast, Experiment I imposed contingencies that strictly differentiated between sensitive and insensitive performances. Sequences that did not include the critical reinforcement criteria were never reinforced, while sequences that did incorporate the criteria always produced a point. (Note that contingency-sensitivity does not imply awareness or the ability to verbally describe the criteria.) Similarly, the IRT > T schedule required that responses meet a particular temporal value in order to be effective. Inter-response times less than that value were never reinforced (although longer intervals could vary). Thus, in Experiment I sensitivity was required in order to earn points. Consequently, sensitive performances ensued.

It seems likely that each of the methodological differences just described were important factors for the findings obtained in Experiment I. However, Experiment I does not provide an analysis of which of these variables was responsible for the incongruous results. Instead, Experiment I provided a convincing demonstration that under certain, specifiable conditions human operant performanes will reflect contingency-sensitivity in the presence of both instructions and shaping interventions. What seems critical to each of the independent variables discussed is an emphasis on the nature of the contact between responding and reinforcer delivery. As with other operant classes, it is likely that the effects of instructions on behavior will be more successfully explained and predicted when the relations between behavior consequences and antecedent stimuli, rather than the antecedent stimuli alone, are considered.

Unlike the nonverbal response patterns, guessing performances in Experiment I were quite similar to those described by the other researchers (Catania et al., 1982; Matthews et al., 1985; Shimoff et al., 1986). In all of these studies, criterion guesses were much easier to establish with instructions than via shaping procedures. This fact does not seem surprising nor even necessarily a reflection on the sensitivity of these verbal responses. The beginning form of the instructed guess was a much closer approximation of the criterion form than was the case for the shaped guesses; thus, the criteria were met more quickly.

Experiment I, however, revealed other interesting facets of guessing patterns when instructions were given and when the guesses were shaped. First, it should be noted that even with instructions, criterion guess forms were rarely emitted on the first guess cycle. In other words, some shaping was necessary to establish a congruence between the instruction and the guess. In one sense, this might even be considered a lack of sensitivity to the guessing contingencies; a simple repetition of the instruction would have been sufficient for maximal point earnings. However, no subject developed a pattern of echoing the instruction. Even in the final criterion form, guesses were not echoic in nature. Instead, they tended to incorporate each of the critical instruction elements in a more specific statement of what was required for reinforcement (e.g., by specifying particular grid locations, or particular points in the sequence where these were nonessential to reinforcement). Thus, echoic responses were not required for reinforcement, they seldom occurred, and it would seem inappropriate to describe their absence as insensitive, even though they could have led to rapid point acquisition.

Another general characteristic of the instructed guess patterns was that once any single guess reached criterion form, subsequent cycles would usually consist of five guesses, each at criterion form. (Most often the five guesses would involve variations of the criterion as opposed to repeating the successful guess verbatim, although an occasional repetition would occur and be reinforced.) In other words, cycles following one successful guess would consistently earn the maximum points possible (i.e., 15). This pattern seems indicative of sensitive adaptation to the point-earning contingencies.

The pattern shown by the shaped guesses was somewhat different, however. For several of the subjects, the total points earned on a guess cycle decreased even as the points earned by a single guess increased. As single guesses became more successful and earned more points, the number of guesses made often decreased. With respect to contingency-sensitivity, this pattern seems odd. Sensitivity to the shaping procedure was clearly reflected in the orderly acquisition of point-earning guesses, yet earnings for an entire cycle were not maximized. At least two different conclusions could be drawn from these seeming disparities in sensitivity. Shaped guessing could be considered insensitive to its consequences, a conclusion that is difficult to align with the acquisition of effective single guesses, or the reinforcing efficacy of points for redundant guesses may be questioned. One possibility is that the functional reinforcer for the present task comes in producing the "solution" to the problem. While this event is signalled by the number of points awarded, the points earned by variations of the solution may be discriminated as superfluous. If problem solutions and not point accrual were the reinforcer, the discrepancy in the two measures of guessing performance would not seem surprising.

It was the case, however, that five variant guesses were maintained (seemingly by point accrual) when guesses were instructed. It then becomes necessary to consider why the accumulation of points might reinforce instructed, but not shaped guesses. One possibility is that the two guessing situations are different with respect to the reinforcers that are available. When guesses are shaped, problem solution is one possible outcome, and additional points earned by solution variations is another. When guesses are instructed, all critical components of the problem solution are provided, leaving only the accumulation of points as a potential source of reinforcement. It may be that when both outcomes are available, problem solution takes precedence and point accumulation becomes relatively unimportant (even though there is no obvious reason why both outcomes would not be reinforcing). On the other hand, when point accumulation is the only possible consequence its relative effectiveness in reinforcing guesses may increase. Obviously, these are only preliminary interpretations and their accuracy is untested. However, if true they could hold some implications for research on instruction effects.

# CHAPTER III

## EXPERIMENT II

Experiment II further compared the effects of instructing versus shaping verbal responses on problem-solving contingency sensitivity by arranging the two problem types in a choice procedure. The rationale for such a procedure was twofold. First, several studies have shown that performance that is undifferentiated across more than one sequentially presented condition may become differrentiated when those conditions are presented concurrently (e.g., Steinman, 1970). Thus, it semed possible that a concurrent arrangement of the two problem types (i.e., shaped and instructed) might reveal differences in responding that were not apparent in Experiment I. Second, subject preference for shaped or instructed problem conditions was of interest in itself. If responding was more sensitive in the presence of one of the two problem types, it might be expected that response allocation would correspond, thereby increasing reinforcement probability and providing another measure of contingency sensitivity. On the other hand, a consistent preference for one problem type in the absence of any demonstrable sensitivity differences might implicate the involvement of some other variable in accounting for discrepancies in performances under shaped and instructed conditions.

## Methods

### Subjects

Subjects in this experiment were four University of Florida undergraduates. Recruitment and remuneration practices were identical to those used in Experiment I. Each subject completed five three-hour sessions held consecutively on Monday through Friday evenings.

### Apparatus

The experimental apparatus was identical to that used in Experiment I.

### Procedure

The basic experimental procedure was also very similar to that employed in Experiment I. Participation began with a presentation of general instructions in oral and written form. These instructions described the two methods of earning points. Subjects responded on the two operant tasks in cycles. Changes in the nature of the two tasks were as follows:

### Key-pressing

As in Experiment I, subjects earned points on this operant task by moving a filled square through a 5 by 5 stimulus grid in patterns that satisfied problem contingencies. No IRT > t contingency was in effect during Experiment II.

Subjects wre presented with a series of four matched problem pairs. The problem pair in effect was always labeled vertically on the far left side of the computer monitor (e.g., Problem Pair 1, Problem Pair , etc.). Again, pair members imposed symmetrically opposite pattern contingencies for moving the square through the stimulus grid. The exact reinforcement criteria for each problem pair are presented in Table 4.

The major change in procedure from Experiment I to Experiment II was that both members of a problem pair were available concurrently. The first pair member presented would remain in effect until one of three events took place; a) the key-pressing period timed out,in which case the guessing portion of the cycle began; b) five trials were completed, in which case the second pair member would go into effect; or c) the subject made a change-over response. The change-over response consisted of pressing the Return key on the computer keyboard. A change-over response could be made at any time, and always resulted in the filled square being reset to the start position. (If the square was in the start position when a change-over response was made, it simply remained there.) Along with the reset, a change-over response immediately changed the problem contingency in effect to that of the second problem member. The new contingency would then be imposed for five trials or until another change-over response as made, which would reinstitute the first problem member, and so on. Thus, the subject was able to control which of the two problem members was in effect at all times. In the absence of change-over response, problem members alternated every five trials.

Table 4: Problem Pairs - Experiment II

| Pair | Order of Presentation | Reinforcement Criteria |
|---|---|---|
| 1 | X | Must hit bottom right corner at least two times.<br>(Instruction = Guess about the bottom, right corner) |
| | Y | Must hit center square at least two times. |
| 2 | X | Must move through the top two squares, but not all, of the fourth column from the right. |
| | Y | Must move through the second and third squares, but not all, of the fourth row from the top.<br>(Instruction = Guess about the middle of a horizontal row) |
| 3 | X | The fifth and sixth responses of the sequences must be the same. |
| | Y | The second and third response of the sequence must be different.<br>(Instruction = Guess about differing moves at the beginning of the sequence) |
| 4 | X | Must make at least two up moves.<br>(Instruction = Guess about a number of up moves) |
| | Y | Must make at least two right moves. |

The problem member in effect was alwaays clearly labeled at the top of the computer monitor, centered over the stimulus grid. The pair member in effect in Cycle 1, Trial 1 of a problem's presentation was labeled Problem X. Thereafter, that problem contingency was labeled similarly whenever it was in effect. The remaining problem member was labeled Problem Y. (Problem labels switched immediately, along with contingencies, at the end of five consecutive trials in the presence of one problem member or at the time of a change-over response.)

Also displayed on the computer monitor was the cumulative number of points earned during that cycle on the problem member in effect at the time. The running tally was presented at the bottom of the screen, centered beneath the stimulus grid, and was preceded by the words "Points scored on Problem X (or Y) =."

The problem member in effect on Trial 1, Cycle 1 for each problem pair is presented in Table 4. On subsequent cycles for each problem pair, the pair member presented on Trial 1 alternated with each cycle. Each problem pair remained in effect until one of three possible criterion were met by both problem members: 1) each trial attempted in a cycle earned a point; 2) the ratio of points earned to trials attempted did not vary by more than 10% over three cycles; or 3) fifteen cycles were completed. Change from one problem pair to another was signalled by the pair label on the left side of the monitor.

## Guessing

The guessing component of each cycle was characterized by few changes from that described in Experiment 1. Subjects were given guess sheets that provided space for responding to the statement "In order to earn points on the computer ...," but in Experiment II a total of ten spaces were provided, five each under the headings "Problem X" and "Problem Y". Thus, subjects were able to make up to five guesses for both members of a problem pair, regardless of their key-press allocations.

For each problem pair, responses on the guess sheet were instructed for one member and shaped for the other. Just prior to the first cycle of a new problem pair, subjects were given a notecard with an instruction specific to one problem member printed on it. Notecards read as follows; "Clue for Problem X (or Y): You should guess about ..." Problem pairs were designed such that the instruction would hold true only for the particular problem member specified. The exact instructions delivered are presented along with the reinforcement criteria for both problem members in Table 4. The notecard remained beside the computer monitor for the duration of a subject's exposure to that problem pair.

The procedures used for awarding points to both the instructed and the shaped verbal responses were identical to those described in Experiment I. In this case however, both strategies were employed on each guess sheet dependent on the appropriate problem member.

The first problem member (i.e., the instructed or the shaped) to be presented for each problem pair was counterbalanced across pairs. Thus, two problem pairs began their first cycle with the instructed member, and two pairs began with the shaped member. From the first cycle on, the problem member in effect on Trial 1 alternated every cycle.

As in Experiment I , the present experimental design allows within-subject comparisons of the effects of instructions versus shaping on response sensitivity by contrasting performances on matched reinforcement contingencies. In addition, Experiment II provides the opportunity to simultaneously investigate preference for one of these two conditions.

## Results

### Computer Points

Figure 11 presents data on the points earned by key-press responding for all four subjects. The number of points earned on each cycle for each problem pair member is divided by the number of trials completed with that contingency in effect. Given the choice arrangement, the number of trials spent working on problem members X and Y differed within each cycle and from one cycle to the next. Therefore, a comparison of the actual number of points earned per cycle for each problem member was not always the best index of response sensitivity to pattern contingencies. For example, after a few cycles a subject might develop a pattern in which she reliably earned a point on the first trial of problem X, then switched to problem Y for the remainder of the cycle. If she proceeded to earn three points intermittently over the next ten trials in problem Y, a simple comparison of points earned would imply greater success with that problem, even though mastery was actually superior with problem X. Therefore, the data for points earned while responding on the computer are presented as the ratio described above. This ratio seems most representative of mastery of, or sensitivity to, a problem contingency.

In general, the acquisition of effective key-pressing sequences was clearly demonstrated in the presence of both shaped and instructed problem conditions. While exceptions did exist in a small number of problem pair comparisons, sensitivity to pattern contingencies was apparent in most, regardless of instruction variables. A more specific comparison of shaped and instructed performances revealed the following relations.

Subject #6 exhibited increasingly effective (i.e., point-earning) sequences throughout her exposure to both the shaped and instructed problem versions of all four problem pairs, although the relative patterns of acquisition varied somewhat from one problem pair to the next. In problem pairs A, B, and D, key-pressing sequences reached maximal levels of effectiveness (i.e., one point for each sequence completed) for both problem members. This level was attained more quickly in the presence of the instructed member of problem pair A, and at approximately the same time for the members of pair B (although sequences had been more effective for its shaped problem member prior to that time). While a programming error prevented a direct comparison of the exact point at which highest effectiveness levels were acquired in problem D, it should be noted that the high level exhibited early in the shaped version of problem D was not stable, and in fact fell to zero before regaining the same level of effectiveness demonstrated in the instructed version. Thus, for problem pairs A, B, and D the acquisition of effective key-pressing sequences varied slightly, but the terminal performances on both problem versions revealed substantial and equal sensitivity to pattern contingencies. Problem pair C resulted in a somewhat different pattern. In this case, the effectiveness of early responding was very similar, but while sequences in the presence of the instructed problem version attained stable,maximally effective levels, responding in the presence of the shaped problem version did not.

In general, the key-pressing performance of Subject #7 was similar in function to that exhibited by Subject #6. In this case, maximally effective responding was acquired on both versions of all four problem pairs. However, this subject's performance was also characterized by an interesting pattern seen only once for Subject #6. There were a number of cycles on which 100% of the key-press sequences were performed in the presence of one problem member, with 0 trials in the presence of the other. In most instances this occurred after a cycle in which a maximal effectiveness ratio had been exhibited in the presence of one problem member. The interesting feature of this pattern was that in each case the problem member excluded was the very one that had been responded to so successfully in the previous cycle. Given this pattern, the stability of "mastered" problem performances looked somewhat different from that exhibited by the other subjects.

For subject #7, maximal sequence effectiveness was acquired much more quickly in the instructed version of problem pairs A and C, and at about the same point in time for the two members of problem pairs B and D. While levels remained comparable for both members of problem D, high levels were maintained more consistently in the shaped version of problem pair B.

Maximal sequence effectiveness was acquired in all but one problem member for Subject #8. Performance in both versions of problem pairs A and B appeared sensitive to contingencies when maximal effectiveness levels were acquired relatively quickly. In problem A, maximal levels were attained immediately in the instructed problem version, while in problem B levels increased more quickly in the shaped problem member. In problem C, maximal levels were again attained first in the instructed member. Subsequent cycles were devoted solely to responding in the shaped member in a manner similar to that described for Subject #7. Finally, sensitive acquisition was demonstrated in both versions of problem D, but maximal levels of effectiveness were attained only in the shaped member.

The performance exhibited by Subject #9 was the most discrepant from that of the other subjects. In fact, the pattern shown by this subject on problem pairs A and C was unlike that exhibited at any other point in the experiment. For these problems, standard acquisition patterns occurred in the presence of the shaped problem member; however, not a single point was earned in the presence of the instructed member for either of the problems. In problem A, a total of two sequences were completed while the instructed problem version was in effect. During the instructed version of problem C, 13 sequences were emitted across four out of the nine cycles presented. Thus, for most of the cycles in question no points were earned because no sequences were emitted, and it is possible that this pattern represents a variation on that discussed previously for Subject #7.

Subject #9's performance on problem pairs B and D was similar to that displayed by the other subjects. In each case key-pressing reached maximal effectiveness levels in both problem members relatively quickly. In problem B, both members reached the maximal level at approximately the same point in time, although highly effective responding was much more consistently maintained in the presence of the shaped problem member. For problem D the maximal effectiveness level was attained somewhat more quickly during the instructed than during the shaped problem version.

In summary, the performances generated in the present experiment appeared extremely sensitive to pattern contingencies under both instructed and shaped problem conditions. In 32 total opportunities (two versions of four problems for four subjects), responding failed to reach maximal effectiveness in only four cases, and in two of those (shaped version, problem pair C, subject #6; instructed version, problem pair D, subject #8) effectiveness levels were still quite high. In the remaining two cases (instructed version, problem pair A, Subject #9; instructed version, problem pair C, Subject #9), the absence of effective response acquisition might be attributed to a lack of contact with the pattern contingency given the extent of the responding that occurred. This pattern does not seem appropriately labeled as insensitivity. Thus, comparing the extent of sequence effectiveness acquired under the two problem conditions revealed no differences in the sensitivity of shaped versus instructed performances. (While it was the case that of the four instances in which maximal effectiveness was not acquired three occured in the presence of instructed problem members, it has been argued that for two of those, insensitivity did not seem to be the issue. For the two remaining cases in which effectiveness levels differed, the less effective performance occurred in the presence of an instructed problem member for one and in the presence of a shaped problem member for the other.)

A comparison of the rate of effective sequence acquisition revealed no more evidence for sensitivity differences than did the level of effectiveness comparison. There were no consistent differences in the extent of contingency exposure necessary to produce acquisition of effective response sequences either within or across subjects. On different problem comparisons, each subject provided evidence of either more rapid or more consistently effective sequence acquisition under both problem versions. Similarly, for each problem pair there was evidence of superior acquisition in each of the problem versions by different subjects.

## Preference Measures

*Trials completed on each problem member.* The present procedure allowed subjects to control the problem member in effect at any given time; therefore, for each cycle the number of trials completed in the presence of each problem member was one important indication of preference. However, it was also the case that problem pair members alternated automatically every five trials if no change-over responses were made. This meant that if a subject made no change-over responses, functionally exhibiting no preference for either problem member, the number of trials completed on the two versions would be discrepant (unless the total number equaled a multiple of ten) even in the absence of preference responding. In order to distinguish between discrepancies due to actual preference responding and those due to standard problem member alternations, Figure 12 presents the number of trials performed on each problem member minus the number of trials that would have occurred on that problem given the total number of trials for the cycle and a standard alternation pattern. For example, in a cycle consisting of ten trials, five trials would be distributed to each of the problem members according to the standard distribution pattern. If the number of trials actually performed in the presence of each problem member were distributed such that 7 trials were completed on Problem X, and 3 trials were completed on Problem Y, the cycle would be characterized by +2 trials for Problem X and -2 trials for Problem Y. The relations revealed by this measure are as follows.

Subject #6 engaged in very few trials that differed from a standard alternation on problem pairs A and B. Problem A resulted in differences on only two cycles. The differences were of equal magnitude and in opposing directions, thus giving no indication of preference for either problem member across cycles. Problem B also resulted in differences on only two cycles; however, these differences were both in the direction of a preference for the shaped problem member. Problem pair C resulted in a much larger and durable preference, also for the shaped problem version, while performance in Problem D revealed a slight, but consistent preference for the instructed problem member.

The performance of Subject #7 was characterized by more and larger variations from standard problem alternation. Here, problem pairs A and B were similar in giving rise to a greater number of trials in the presence of the shaped problem member. Although there were several cycles in both cases where the instructed problem version was preferred over standard levels, overall performance was weighted in favor of the shaped member. In problem C trials were distributed more often towards the instructed problem version, but the shaped member was favored again in problem D.

Subject #8 completed two problem pairs, pairs A and D, with no variation from standard alternations on any but the first problem cycle. Similarly, there was little variation during initial exposure to pairs B and C; however, by about the seventh cycle of both problems preference had developed, with a larger than standard distribution of trials in the presence of the shaped problem members.

For Subject #9, the first three problem pairs (A, B, and C) were all characterized by trial distributions in favor of the shaped version. The variations were consistent and often substantial. Problem pair D was also weighted in favor of the shaped member although there were several cycles in which no variations from standard occurred, and one in which a greater than standard number of trials occurred on the instructed problem member.

In summarizing these results across subjects, an interesting relation becomes apparent. Out of 16 total problem pair comparisons, preference in the form of trial distribution was shown for the instructed problem member in only two cases (one example for each of two different subjects). There were three comparisons in which no preference was demonstrated for either problem member (one example for one subject, and two examples for another subject). For the remaining 11 comparisons, trials were distributed more often towards the shaped problem version. Although the differences were either small or inconsistent in two of the examples, there does seem to be a tendency for these subjects to prefer responding in the presence of shaped problem conditions as compared to instructed. In addition to the total percentages just described, a preference for the shaped member was the most common pattern exhibited across problems for three of the subjects, and was tied with no preference as the most common pattern for the fourth.

Change-over Responses. While the trial distribution data described above gave an indication of the overall functional effect of change-over performance on each cycle, the actual number of change-over responses made in the presence of each problem member gives a more complete picture of the moment-to-moment choices made. Figure 13 presents the change-over data as the number of responses made in each cycle that resulted in the production of each problem member. (The alternative was to present the number of responses resulting in the removal of each problem member. These two display alternatives would present exactly the same data in mirror images of each other.) As presented, the higher the number of change-over responses shown for a given problem member, the greater the preference for that member.

Subject #6 made many change-over responses for both problem members on the first two trials of problem pair A, but quickly settled into more stable change-over responding. In problem pairs A, B, and C a greater number of responses were made to produce the shaped problem version. Differences were modest in pairs A and B, but more substantial in pair C. Performance on Pair D was different with a greater number of responses made to produce the instructed member of the pair. These patterns present a very similar picture to that revealed by the trial distribution data. The only difference seemed to be that while the differences in trials from standard were equal in pair A, the number of change-over responses was weighted slightly in favor of the shaped member. For change-over performance then, the shaped problem seemed to be preferred in three of four problem pairs.

The patterns of change-over responses made by Subject #7 were similar. While performance on all four pairs included change-overs to produce both problem members, the shaped member was produced on more occassions than the instructed in pairs A, B, and D. Only for pair C was the instructed problem member preferred a greater number of times. As was the case for trial distribution, change-over performance indicated preference for the shaped problem version in three of the four pairs.

Subject #8 engaged in the least change-over responding of the four subjects. Indeed, for problem pairs A and D the absence of such responses gave the indication of no preference for either of the problem members. Problem pairs B and C did result in change-overs, with a majority producing the shaped problem member in both pairs. Again, these patterns reproduced those shown for trial distributions.

The change-over performance exhibited by Subject #9 also reproduced the relations shown by trial distributions. In this case, the shaped problem member was produced more often than the instructed in all four problem pairs.

In summary, the instructed problem member was produced more often than the shaped in two of the 16 pair comparisons (one each for two different subjects). The number of change-over responses was approximately equal for the two problem versions in another two comparisons (both for Subject #8). The remaining 12 comparisons revealed a majority of the change-over responding made to produce the shaped problem member. Thus, the two preference measures described are in agreement in indicating a tendency by all four subjects to prefer responding in the presence of the shaped problem conditions.

Interestingly, this preference occurred despite the absence of any appreciable differences in response sensitivity to the two problem versions. In fact, there appeared to be no correlation between performance sensitivity as indicated by points earned/trials completed and problem member preference (that is, the problem version in effect during the more sensitive performance of a problem pair was no more likely to be preferred than the problem version in effect during the less sensitive sequence pattern). It was the case that the actual number of points earned on each member of a problem pair correlated with preference measures (that is, the problem version in which the greatest number of points were scored was more likely to also have been produced most often by change-over responses). However, there was no evidence that increases in point-earnings were a prerequisite for preference responding. Instead it seemed that points increased for particular problem members when preference was shown. (It would be expected that, given similar response sensitivity, a greater number of points would be earned on the problem member that had the greater number of trials.)

### Points Scored by Guessing

Overall, the guessing performances in Experiment II showed the same general relations as those exhibited by the subjects in Experiment I. Although guesses were sensitive to the contingencies for earning points in both the shaped and instructed conditions, the instructed performances were clearly superior. Another similarity between the performances obtained in the two experiments was that the highest number of points earned by any single guess on a cycle was more indicative of orderly acquisition than was the total number of points earned on the cycle. As in Experiment I, the actual number of guesses made varied from cycle to cycle, leaving the total number of points a poorer indication of guess effectiveness in many instances. Figure 14 presents the total number of points earned by guesses for each cycle of both problem members, the highest number of points earned by any single guess on a cycle, and the number of guesses made on each cycle for subjects #6 and #7. Figure 15 presents the same data for subjects #8 and #9. The results for each subject are as follows.

The guessing performance of subject #6 was consistent with each of the generalities described above. As compared to the shaped problem member, total points earned by guessing were higher in the instructed version of all four problem pairs. While there was evidence of effective quess acquisition during the shaped members of all four pairs, guessses were shaped to maximal point-earning criterion in none. Conversely, instructed guesses made by Subject #6 were particularly impressive in that at least one guess in each cycle of each problem pair earned the most points possible with a single exception. Total point earnings did not refect this fact, largely because the number of guesses made per cycle were less than the number possible.

For Subject #7, instructed guesses again reached their highest possible levels in each problem pair, this time for both points per single guess and total points scored in the cycle. Shaped guesses also showed increases, although to lesser levels, in points earned per single guess in problem pairs A, B, and D. Furthermore, the shaped guessing in pair A was characterized by a number of cycles in which no guesses were made, and for problem pair C, guesses were made under the shaping conditions in only two of the nine problem cycles. Quite possibly because of the limited responding for shaping purposes, no point-earning guesses were ever acquired for the "shaped" member of pair C.

The performance of subject #8 showed a slight variation from that of the other two subjects described so far. Single instructed guesses continued to reach their maximal levels for each problem pair; however, for problem pairs A and B shaped guesses did too. Furthermore, shaped responding reached levels comparable to those of the instructed problem pairs as measured by total points scored as well. For pairs C and D, total points scored were still highest in the presence of the instructed problem version.

Finally, the guessing performance exhibited by subject #9 was quite different from that of the other subjects. The shaped guesses of each problem pair continued to show clear acquisition, especially as measured by the highest points earned by a single guess, and to a lesser extent by the total points earned per cycle (maximal point-earnings per guess were not acheived in any problem). However, the major difference in the guessing patterns exhibited by subject #9 was the absence of a single guess about an instructed problem member for the entirety of the first three problem pairs. When guesses were made during instructed conditions in problem pair D, maximal levels were quickly attained in the single guess measure and total points

Figure 11. Number of points earned on each problem during commputer responding divided by the number of trials completed on that problem. Each data point represents performance on one cycle of computer responding. Filled data points represent performances when guesses were shaped. Open data points represent performances when guesses were instructed.

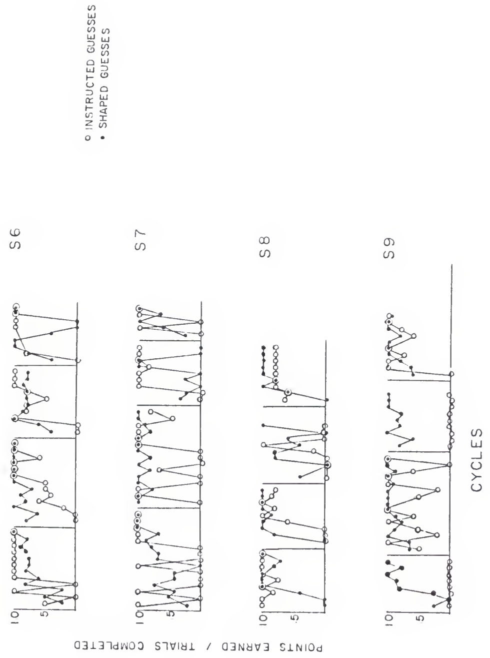

○ INSTRUCTED GUESSES
• SHAPED GUESSES
S6
S7
S8
S9
10
5
POINTS EARNED / TRIALS COMPLETED
CYCLES

Figure 12. Number of trials completed on each problem that differed from standard alternations of problem presentation. Each data point represents performances for one cycle of computer responding. Filled data points represent performances when guesses were shaped. Open data points represent performances when guesses were instructed.

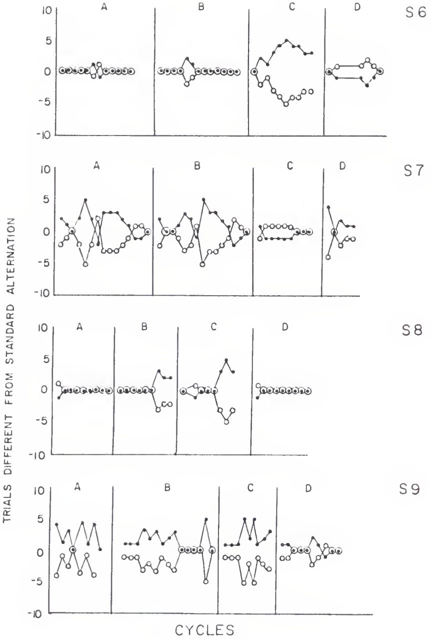

S6
S7
S8
S9
A
B
C
D
10
5
0
-5
-10
TRIALS DIFFERENT FROM STANDARD ALTERNATION
CYCLES

Figure 13. Total number of change-over responses made to produce each problem. each data point represents performance on one cycle of computer responding. Filled data points represent performance when guesses were shaped. Open data points represent performance when guesses were instructed.

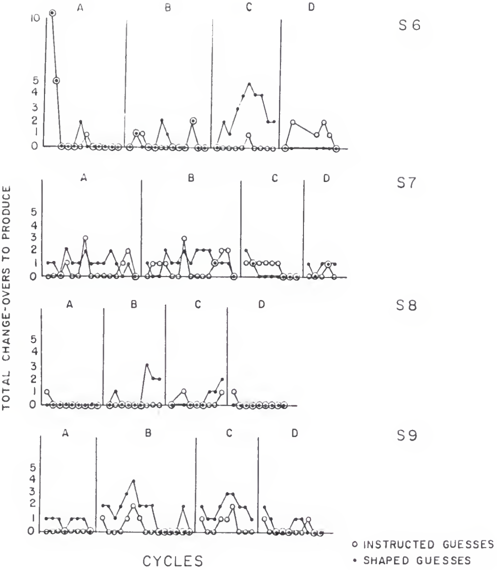

A
B
C
D
S6
10
5
4
3
2
1
0
S7
S8
S9
TOTAL CHANGE-OVERS TO PRODUCE
CYCLES
o INSTRUCTED GUESSES
• SHAPED GUESSES

Figure 14. Guessing performances for Subjects 6 and 7. The top panel for each subject shows the total number of points earned by guessing on each cycle. The middle panel for each subject shows the most points earned by any single guess on each cycle. The bottom panel for each subject shows the total number of guesses made on each cycle. Filled data points represent performance when guesses were shaped. Open data points represent performance when guesses were instructed.

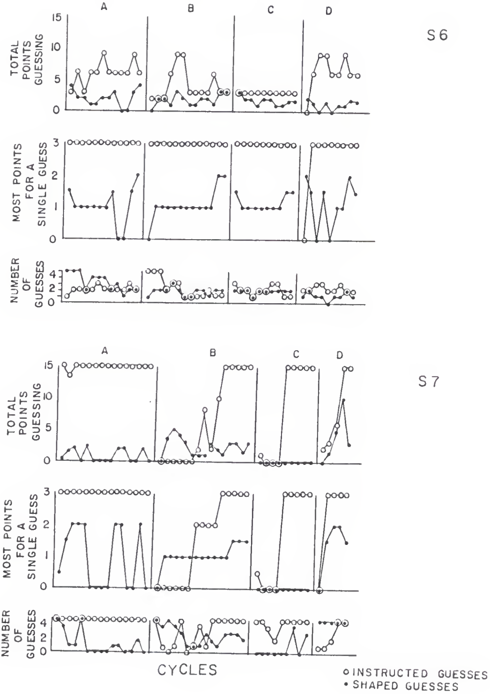
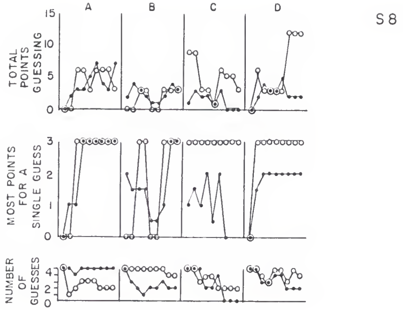
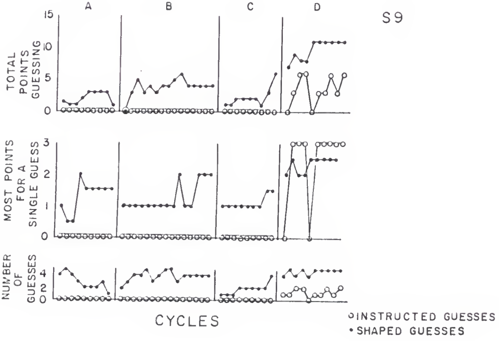

A
B
C
D
S6
TOTAL POINTS GUESSING
15
10
5
0
MOST POINTS FOR A SINGLE GUESS
3
2
1
0
NUMBER OF GUESSES
4
2
0
A
B
C
D
S7
TOTAL POINTS GUESSING
15
10
5
0
MOST POINTS FOR A SINGLE GUESS
3
2
1
0
NUMBER OF GUESSES
4
2
0
CYCLES
○ INSTRUCTED GUESSES
• SHAPED GUESSES

Figure 15. Guessing performances for Subjects 8 and 9. The top panel for each subject shows the total number of points earned by guessing on each cycle. The middle panel for each subject shows the most points earned by any single guess on each cycle. The bottom panel for each subject shows the total number of guesses made on each cycle. Filled data points represent performance when guesses were shaped. Open data points represent performance when guesses were instructed.


A
B
C
D
S8
15
10
5
0
TOTAL POINTS GUESSING
3
2
1
0
MOST POINTS FOR A SINGLE GUESS
4
2
0
NUMBER OF GUESSES


A
B
C
D
S9
15
10
5
0
TOTAL POINTS GUESSING
3
2
1
0
MOST POINTS FOR A SINGLE GUESS
4
2
0
NUMBER OF GUESSES
CYCLES
○ INSTRUCTED GUESSES
• SHAPED GUESSES

earned were high, although still lower than those of the shaped problem member.

In summary, for three of the four subjects instructed guesses earned both more total points and higher points for single guesses in ten out of twelve comparisons. The exceptions were both from the same subject (#8), and involved point-earnings that were closely matched overall on the total points dimension. Although the performances of these three subjects were relatively consistent, those of the fourth subject showed none of the same relations. Higher point totals were scored in the presence of the shaped problem member on all four problems, even the one that resulted in some instructed guesses. Overall, however, it still seemed clear that both shaped and instructed guesses, when they occurred, revealed sensitivity to point-earning contingencies.

## Discussion

In Experiment I, some small but interesting differences were noted when subjects' guesses were shaped and when they were instructed. It has been found that in some cases variables that have small effects may produce larger ones when incorporated within a concurrent schedule arrangement (Catania, 1984). Therefore, Experiment II arranged a concurrent problem-solving procedure in an effort to better expose any effects of the two manners of establishing verbal responses. Furthermore, a choice arrangement is a good candidate for providing a measure of reinforcement value. Thus, it seemed possible to assess whether or not subjects would respond differentially with respect to performances that could earn only points and those that could produce solutions as well as points.

Results from Experiment II reproduced several of the important findings from Experiment I. In general, no differences in sensitivity to point-earning contingencies were evident for nonverbal responding. Sensitive acquisition patterns were exhibited for the key-pressing sequences in both the shaped and the instructed conditions. Indeed, this was true for the rate as well as the level of effectiveness that was attained.

However, the measures allowed by the concurrent arrangement revealed some interesting patterns of nonverbal responding in addition to those reported in Experiment I. For example, one pattern observed on a number of problems was a change in trial allocation following a cycle on which complete effectiveness had been achieved for one member of the concurrent pair. In each of the cases in question, all trials on the next cycle were completed on the other problem member. While this was not a frequent pattern, it was observed for three of the subjects. (Interestingly, in all five instances the alternative that was characterized by effective responding and was then avoided had had instructed guesses.) This pattern is perhaps more striking because there were no other instances of zero trials completed on a problem alternative. One possible explanation of this pattern is consistent with the functional reinforcer approach discussed previously. That is, once a problem contingency had been mastered, earning additional points on that problem had less reinforcing value than the opportunity to respond on a unmastered problem contingency. In other words, mastery was the reinforcer, rather than point production.

The same interpretation could be made of the fact that preference was revealed for responding on the shaped problem alternatives. It should be stressed at this point that any interpretations must be made very cautiously. The preference that was exhibited was not overwhelming, nor was it even evident in all comparisons. It was typical, however, and difficult to account for with other experimental variables. Given that preference may reflect a difference in reinforcer magnitude (e.g., Catania, 1984) and that response sensitivity to the concurrent contingencies appeared equal (i.e., points could be produced in each problem member with equal success), one possibility is that the shaped problem members were preferred because the reinforcers available there (i.e., producing solutions and points) had a greater value than the reinforcers available when guesses were instructed (i.e., points).

The guess performances exhibited in Experiment II were very much like those seen in Experiment I. Sensitive acquisition of successful guesses was demonstrated in both instruction and shaping conditions, when guesses occurred. Also as in Experiment I, instructed guesses tended to improve more rapidly and to a more successful level than did those that were shaped.

Another similarity to the findings of Experiment I concerned the fact that patterns of acquisition were much more orderly as measured by the most points earned by a single guess than as measured by the total number of points scored on the entire guessing cycle. In fact, in Experiment II this was true not only for the shaped guesses but for the instructed guesses as well. As described previously, the pattern resulted because even as single guesses became progressively more successful, the number of guesses actually made often decreased. Indeed, the number of instructed guesses made were often less than five, even when single guesses were earning the maximum of three points. Once again, these relations may indicate that point accrual had little reinforcing effectiveness relative to producing problem solutions. As long as a solution was produced during a guess cycle (i.e., by a single guess), accumulating points seemed to provide relativly little extra motivation. This possibility might account for the seeming discrepancy between the sensitive acquisition shown by the single guess effectiveness and what seemed to be a relative insensitivity shown by the total points measure.

It is also interesting that in Experiment II the pattern just described was typical of both instructed and shaped guessing. In Experiment I, the same pattern was characteristic of only the shaped guesses; (only twice during the entire experiment were fewer than five guesses made after an instructed guess had earned three points). This difference requires a consideration of differences in the experimental conditions present for guessing in the two experiments. The most obvious difference between the two was that in Experiment I, the guesses made for any one cycle were either instructed or shaped. In contrast, Experiment II arranged for both instructed and shaped guesses to be made on each cycle. (Guessing for one of the problems in no way restricted the guesses that could be made for the other.) Thus, in Experiment II producing solutions was available as a reinforcer on each cycle, while in Experiment I this was the case only during shaped guess cycles. As suggested previously, it might be that having the opportunity to produce a solution functionally decreased the reinforcing efficacy of point accrual.

It is important to note that instructed guessing was still well maintained (at least for three of the four subjects); in fact, for those three subjects there were no overall differences in the number of instructed and shaped guesses made. Indeed, this may be as expected given that those guesses superfluous to problem solution had a similar consequence, whether instructed or shaped. Still, it did seem that fewer instructed guesses were made in Experiment II than in Experiment I (where producing solutions was not a concurrent possibility), especially when the maximum number of points had been earned by a single guess. As in Experiment I, these interpretations are suggested very tentatively. However, there does now seem to be increased support from two sets of experimental findings.

# CHAPTER IV

## Experiment III

In Experiment II, no evidence was found of a relation between sensitivity to problem contingencies and preference for a given problem member. In general, there are at least two possible ways to account for this lack of correspondence. One possibility is that sensitivity was equivalent under the two instruction conditions, and that the differential choice performance demonstrated was due to some other variable. An alternative possibility is that sensitivity under the two conditions was not really equivalent but, despite the concurrent arrangement, the experimental procedure still did not allow the difference to be detected. It may be that the effects of the instructions delivered for one problem member were sufficiently widespread that performance in the presence of the concurrently-programmed problem member was affected as well. In fact, there was some indication discussed in the results of Experiment II that the concurrent availability of an instructed problem member may have changed the pattern of guessing during the shaped problem member, as compared to the guessing performances observed under sequential presentation conditions.

Experiment III was designed to investigate these possibilities more closely. Performances on two versions of a given problem contingency were compared, as in Experiments I and II. However, in Experiment III both versions of the contingency were presented under the same instruction conditions (i.e., guesses were either instructed for both versions or shaped for both versions). The comparison of interest involved the nature of the concurrent alternative. One version of each problem set was paired with an alternative that had shaped guesses, the other with an alternative that had instructed guesses. Thus, the effects of being paired with each of the two alternative problem-types (i.e., those with instructed and shaped guesses) could be assessed. Any differences revealed by such a comparison might give evidence for a generalized instruction effect, or one potent enough to affect responding on another problem member.

## Methods

### Subjects

Subjects in the experiment were the same four who participated in Experiment II. Remuneration practices were identical to those used in Experiments I and II. Each subject completed two three-hour sessions held consecutively on the Monday and Tuesday evenings following Experiment II.

### Apparatus

The experimental apparatus was identical to that used in Experiments I and II.

## Procedure

The basic experimental procedure was very similar to that employed in Experiment II. No additional experimental instructions were given, and the completion of Experiment II/ beginning of Experiment III was not signalled to the subjects in any way. Subjects continued to respond on the two operant tasks in cycles. Changes in the nature of the two tasks were as follows.

## Key-pressing

As in Experiment II, subjects were presented with a series of four concurrently-programmed problem pairs. The reinforcement criteria for the members of each problem pair were symmetrically opposite one another. The major change from Experiment II involved the arrangement of the problem pairs. The reinforcement criteria for all problem members used in Experiment III met the following specifications. For each problem member, a combination of two particular grid positions had to be included in each key-pressing sequence in order to earn a point. These grid positions had to come from different rows and different columns, had to include a position from the outside border and one from the inside of the grid, and had to be at least two moves apart from each other. No combination required that any moves be made in a direction away from the goal, but the order in which positions were included in a sequence was unimportant. Finally, no combination could be included in a simple alternation of left and down moves (a common sequence). Because all problem members conformed to these same specifications, there was equality across problem pairs, as well as members, on all controllable dimensions of problem "difficulty" (i.e., number of moves to complete a successful sequence, complexity of sequence required, etc.).

Unlike Experiment II, the two members of a problem pair were not presented concurrently. Instead, one version of a problem contingency was presented together with an instructed member from another pair; the other version of the contingency was presented with a shaped member of a different pair. (The reinforcement-criteria design described above allowed such arrangements to be made.) Thus, comparisons could be made between performances on the same problem when it was presented with an instructed and with a shaped alternative. Two problem pairs consisted of instructed members and two consisted of shaped members; this provided comparisons of instructed versus shaped partners for two different instructed problems and two different shaped problems. Table 5 presents the reinforcement criteria for each problem member, the instructions where applicable, the members that were presented concurrently, and the order of their presentation. All other facets of key-pressing were identical to those described for Experiement II.

## Guessing

Procedures used for guessing were very similar to those of Experiment II. The single difference corresponded to the

Table 5: Problem Pairs - Experiment III

Grid positions are designated as follows:

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 |
| 16 | 17 | 18 | 19 | 20 |
| 21 | 22 | 23 | 24 | 25 |

Problem Pairs

Pair A (Instructed Guesses)

1) Positions 3 and 12 must be in the sequence

(Instruction = Guess about the borders of the upper, left quadrant)

2) Positions 15 and 18 must be in the sequence

(Instruction = Guess about the borders of the lower, right quadrant)

Pair B (Instructed Guesses)

1) Positions 19 and 22 must be in the sequence

(Instruction = Guess about parts of rows 4 and 5)

2) Positions 7 and 16 must be in the sequence

(Instruction = Guess about parts of columns 1 and 2)

Pair C (Shaped Guesses)

1) Positions 14 and 16 must be in the sequence

(Shaping criteria = Guesses about part of the mid-grid and the left border)

2) Position 8 and 22 must be in the sequence

(Shaping criteria = Guesses about part of the mid-grid and the bottom border)

Table 5--continued

Problem Pairs

Pair D (Shaped Guesses)

1) Positions 9 and 23 must be in the sequence
   (Shaping criteria = Guesses about parts of columns 3 and 4)

2) Positions 9 and 11 must be in the sequence
   (Shaping criteria = Guesses about parts of rows 2 and 3)

Concurrent Arrangements

First Concurrent Pair
- A1 (Instructed Guesses)
- B1 (Instructed Guesses)

Second Concurrent Pair
- C1 (Shaped Guesses)
- D1 (Shaped Guesses)

Third Concurrent Pair
- A2 (Instructed Guesses)
- D2 (Shaped Guesses)

Fourth Concurrent Pair
- C2 (Shaped Guesses)
- B2 (Instructed Guesses)

arrangement of problem members. When two instructed problem members were presented concurrently, the presentation of two instruction notecards was also necessitated, one each for each of the problem members. As before, the cards were labeled accordingly. For the concurrent arrangement in which neither member was instructed, no cards were delivered. Otherwise, the subjects guessed and received points as in Experiment II.

## Results

### Computer Points

In general, the key-pressing data from Experiment III very closely reproduced the relations reported for this measure in Experiment II. No consistent differences in sensitivit;y were detected as a function of the type of concurrent alternative. In fact, sensitivity was demonstrated in the presence of both instructed and shaped problem alternatives for most of the pairs presented (exceptions will be discussued below). In the presence of an instructed alternative had somehow decreased overall performance sensitivity, responding might be expected to be more effective when the problem alternative was shaped. (Moreover, this relation might be expected to be particularly pronounced when the problem itself was shaped. It is possible that a problem with guesses that had already been instructed might fail to show further effects from the instructional stimuli provided for a concurrent alternative.) However, the data from Experiment III revealed no evidence that sequence effectiveness (i.e., points earned per sequence completed) was lower when the concurrent alternative was instructed than when it was shaped.

As in Experiment II, points earned by key-pressing are presented for each cycle as the ratio of the number of points earned on each problem member divided by the number of trials completed in the presence of that member. These data are presented in Figure 16. For ease of comparison, the data from the two versions of each matched problem pair are presented together (as opposed to presenting the data from concurrent alternatives together). Thus, the functions plotted together represent data for the same problem contingency, once when its concurrent alternative was shaped and once when the alternative was instructed. The functions do not represent performance on the alternatives. The specific relations revealed for each subject are as follows.

The performance of subject #6 was exemplary of the general relations described above. Improvements in key-pressing effectiveness were demonstrated in the presence of both the instructed and the shaped alternatives for all four problem pairs. However, given the duration of contingency exposure, the highest effectiveness level was attained in only two problems (A and C), and in both cases this level was attained when the concurrent alternative was instructed. Sequence effectiveness also increased for these problems when the concurrent alternative was shaped, but to lesser levels. In contrast, a somewhat higher level of effectiveness was reached on Problem B when the alternative was shaped, while sequence effectiveness was exactly the same, cycle for cycle, with the two alternatives in problem D.

Subject #7 responded at similar levels of effectiveness under the two alternative conditions for all four problem pairs. For problem pairs A and B, sequences did reach slightly higher levels when an instructed alternative was arranged, but only after much more exposure than that allowed when the alternative was shaped. With similar amounts of exposure, levels were most comparable. In pair C, responding reached the highest level of effectiveness possible with both alternatives, and at the same time. Performance in problem D did not reach those levels, but did show the same matching rates of acquisition. Another characteristic of the patterns shown by subject #7 was an occasional steep drop in the levels of sequence effectiveness. It should be noted that each time this occurred, either one or zero trials were completed on that problem member on that cycle. In as much as the prior performances were never at the maximal level of effectiveness, these drops may represent a change in preference rather than in mastery of the contingency.

Subject #8 also demonstrated very comparable rates of effective-sequence acquisition for the two versions of problem pairs A and D. In both cases responding reached a level where each sequence completed earned a point. This occurred on the same cycle of exposure for the two versions of pair D, and a little earlier when the alternative was instructed for pair A.

In pairs B and C the pattern varied slightly. Sequences reached the maximal effectiveness level when the alternative was shaped in problem B, and effectiveness also increased well when the alternative was instructed, though not to the same level. However, in problem C the high effectivenss levels earned when the alternative was shaped were not matched at all when the alternative was instructed. In the latter condition no points were scored on any cycle. However, it seems most important to note here that a total of only three sequences were ever completed on this problem version; again, perhaps an indication of preference rather than sensitivity.

Finally, Subject #9 was an exception to the general statements made previously about key-pressing performances. For this subject, the maximum level of effectiveness was attained when the concurrent alternative was shaped in all four problems. However, the same level was reached when the alternative was instructed in only problem A. Performance accompanying the instructed alternative did show sensitive increases in problem pair D; however, in pairs B and C no points were earned when the alternative was an instructed one. As with subject #8, it was also the case that very few sequences were actually attempted in these instances. For pair B, a total of ten sequences were completed when the concurrent alternative was instructed, and for pair C only four sequences were completed. Thus, especially for pair C, the issue of sensitivity may be secondary to a lack of active exposure.

In sum, with the exception of subject #9, contingency sensitivity as represented by sequence effectiveness was very comparably demonstrated in the presence of the two types of concurrent alternatives. For subjects 1, 2, and 3, somewhat higher effectiveness levels were obtained in two comparisons when the alternative was instructed, levels were somewhat higher when the alternative was shaped in three comparisons, and the levels were equal for the two alternative types in another seven comparisons. Even if analysis is restricted to the two shaped problem pairs (C and D), in which the impact of an instructed concurrent might be easier to discern, there was no indication of sensitivity differences as a function of the alternative's instruction condition. For these comparisons the relative effectiveness levels were higher when the alternative was shaped in one case, instructed in another case, and they were equal for the two alternatives in the remaining four cases. Nothing about the relations revealed by these three subjects indicated an influence on responding by the instruction condition of the concurrent alternative. Subject #9, on the other hand, acquired more effective responding when the alternative was shaped in three of four comparisons. While it may be possible that for this subject, sensitivity was somewhat greater with shaped than with the instructed alternative condition, a more likely possibility is that the difference in effectiveness resulted from differential exposure to the problem contingencies.

## Preference Measures

Trials completed one each problem version. For Experiment III, the data of major interest were the relative sensitivity mesaures. However, preference data were also of interest because they provided a second opportunity for assessing the preference relation reported in Experiment II. Furthermore, Experiment III allowed a test of the extent of such a preference.

The preference data for Experiment III are presented in Figure 17. The left side of the figure presents the difference between a standard alternation pattern and the number of trials actually completed on each cycle of each problem version, as was described for Experiment II. Figure 17 also presents the number of change-over responses made to produce and to remove each problem. As in Figure 16, the data presented together for comparative purposes are from matching problem versions rather than from the two concurrently-arranged problem alternatives. However, it seems important to point out that the preference relations reported from Experiment II (in which a shaped and an instructed alternative were presented concurrently) were reproduced in the relevant portions of Experiment III (i.e., The third and fourth concurrent arrangements presented one instructed and one shaped problem alternative. See Table 5.) For these eight comparisons of interest (two problem sets for four subjects), responding indicated a preference for the shaped alternative in five cases and for the instructed alternative in three cases. Thus, overall, a slight tendency existed for subjects to complete sequences in the presence of a shaped problem member more often than an instructed member when such a choice was possible.

In reading Figure 17 it is important to remember that the functions represent data for a given problem contingency either when the alternative was instructed or when the alternative was shaped. The trials plotted are not for the alternatives themselves. The relations of primary interest in Experiment III were as follows.

In general, there were no consistent differences in the trials completed on a problem as a function of the type of alternative presented concurrently. If some generalized instruction effect had existed such that responding was less sensitive with an instructed partner present, more trials might have been expected on a problem when it was paired with an instructed alternative than when it was paired with a shaped alternative. There was no evidence of such a relation. Even when the analysis is restricted to those problem pairs composed of shaped members (Pairs C and D) so that the presence of a problem's own instruction could not mask generalized effects, there was no evidence of consistent differences in trials completed. The data for each subject were as follows.

Subject #6 completed more trials relative to standard when the alternative was instructed for two of the problem pairs (A and D), and more when the alternative was shaped for the other two pairs (B and C, although the differences revealed in

Problem C were slight). Further, these patterns were distributed such that there was one example of more trials with an instructed alternative and one example of more trials with a shaped alternative for both the instructed problem pairs and the shaped problem pairs.

Subject #7 exhibited an unclear pattern for problem pair A. Trials completed were somewhat higher when the alternative was a shaped one as long as the extent of exposure to the two concurrent arrangements was equal. However, trials completed when the alternative was instructed increased with additional exposure. For the other instructed problem pair, more trials relative to standard were completed when the alternative was instructed. The two shaped problem pair relations included one with an equal number of trials completed on the two problem presentations, and one with more trials completed when the alternative was instructed.

The performance shown by Subject #8 was quite similar to that of the previous two subjects. For instructed problem pairs, trials completed were greater once when the alternative was instructed (although actual discrepancies were slight) and once when the alternative was shaped. For both shaped problem pairs, the relative trials completed were greater when the alternative was shaped. However, the discrepancy between the two problem versions was also very slight for problem pair D.

Finally, for Subject #9 instructed problem pair relations included more trials completed once when the alternative was instructed and once when it was shaped. The same was true for shaped problem pair members. More trials were completed once for each alternative type.

In summary, the trials completed on a given problem contingency did not seem to be influenced by the instruction condition of the concurrent alternative. Overall, more trials relative to standard alternations were completed when the alternative was instructed in seven comparisons (although the difference was slight for one of these), and more were completed when the alternative was shaped in eight comparisons (with differences being marginal in three comparisons). For one comparison, the trials completed were equivalent in both problem presentations. The same overall relations were characteristic of the analysis restricted to problem pairs C and D. For these eight comparisons, more trials were completed when the alternative was instructed in three cases; more were completed when the alternative was shaped in four cases; and trials completed were equal in one comparison. These relations indicate that, like sensitivity, preference for responding on a given problem contingency was not a function of the alternative's instruction type.

Change-over Responses. Figure 17 also presents the change-over response data for all four subjects. Again for ease in making the comparison of interest, the data from the two versions of each matched problem pair are presented together rather than the data for each concurrent pair. For this reason it was necessary to present both the change-over responses that produced a problem version and those that removed a problem version. Thus, any data point above the x axis represents the number of change-over responses that produced a given problem, while data points below the x axis represent change-over responses that removed a problem.

In general, the change-over data revealed the same preference relations described for the previous preference measure. There were no consistent relations between the change-over responses made to produce or remove a problem, and the instruction condition of the concurrent alternative. The specific functions shown for each subject were as follows.

For subject #6, change-overs to produce a member of problem pair A were greater when the alternative problem was instructed, and although there was some overlap, more responses were made to produce problem B when the alternative was shaped. Relations for these two problems mirrored the trial distribution data. For both pairs C and D, more responses were made to produce a problem when the alternative was instructed, however, for one cycle on problem C more responses were also made to remove a problem when the alternative was instructed. This characteristic may account for the fact that problem C was the only one to show a different relation in change-over data than in trial distribution data.

Change-over performance for subject #7 also matched the relations shown by trial data very closely. Responses were made to remove problem A more often when the alternative was instructed, (although the relation also included one cycle in which more responses were made to produce the problem when the alternative was instructed). For pairs B and D responses to produce the problem member were made more often when the alternative was instructed, while for pair C responses to produce the problem member were made equally often for the shaped and the instructed alternative.

For subject #8, functions again were very similar for the two preference measures. Problem A was produced often with both alternative types, and at approximately equal rates overall. Problems B and C were produced more often when the alternative was shaped, while problem D was removed less often when the alternative was shaped.

For subject #9, general preference relations were reproduced for each problem. Problem A was produced much more often when the alternative was instructed, while problem B was removed much more often under the same conditions. Problem C was produced more often when the alternative was shaped, although on one cycle the problem was removed then as well. Finally, problem D was removed more often when the problem was shaped.

In summary, the two measures just described provided another opportunity to assess the influence of alternative instruction-type on problem preference. In this case the two problem members compared were similar on every dimension possible except one. They varied with respect not to their own instruction type but to the instruction-type of the problem alternative with which they were paired. For these matched problem pairs, there were no consistent differences in preference as a function of the alternative instruction-type. However, the preference relation reported in preference as a function of the alternative instruction-type. However, there were no consistent differences in preference as a function of the alternative instruction-type. However, the preference relation reported in Experiment II was reproduced. When preference within a concurrent arrangement was considered, there was a tendency to respond so as to complete trials in the presence of the shaped problem alternative.

### Points Scored by Guessing

The final measures of interest from Experiment III involved guessing performances. Figure 18 shows the total number of points earned per cycle for each problem version, the most points earned by any single guess on a cycle, and the number of guesses made on a cycle for all four subjects. As in Figures 16 and 17, the data from matching problem versions are presented together for ease of comparison.

The relations revealed in Figure 18 were very similar to the guessing performances described in Experiments I and II. As described previously, the most points earned by any single guess often gave the best portrayal of orderly guess acquisition. As judged by this measure, there was evidence of sensitive increases in guess effectiveness under both instructed and shaped conditions in almost every case (exceptions will be discussed below). Overall, instructed guessing (i.e., problem pairs A and B) reliably earned more points than shaped guessing (i.e., problem pairs C and D), and quickly resulted in the maximum points possible for at least one guess of each cycle. Conversely, the maximum of three points per guess was never attained when guesses were shaped. Undoubtedly, the more limited amount of exposure to guessing contingencies provided in Experiment III was at least partially responsible for this fact, however, this same trend was noted in Experiment II as an interesting discrepancy between the guessing performances of Experiment I and those found under concurrent arrangements. The fact that this failure to reach maximum effectiveness occurred when the problem alternative was shaped as well as when it was instructed at least ruled out the possibility that the presence of a desensitizing instruction was responsible for the differences.

Most importantly for purposes of this experiment, there was no evidence that guess effectiveness varied as a function of the type of alternative with which they were paired. This was true for both instructed and shaped problem pairs as measured by either the total number of points scored on a cycle or by the most points scored by any one guess on a cycle. Specific relations were as follows.

Subject #6 was representative with respect to the orderly increases in guess effectiveness demonstrated across cycles in each version of each problem pair. As described above, three points were earned by at least one guess on every cycle of instructed problem pairs A and B, regardless of alternative type. Total point earnings did not reach maximum levels however, because the number of guesses made were always less than five. Although total points earned were slightly higher for these two problems when the alternative was shaped, this fact was accounted for by the minor variance in the number of guesses made on any given cycle rather than by any evidence of differing sensitivity to guess contingencies. Compared to problems A and B, fewer points were earned on shaped problem pairs C and D, both for single guess scores and for cycle totals. For problem C the most points earned by one guess reached equal levels with the two alternatives, although total points were marginally higher when the alternative was instructed. For problem D higher levels were attaifned by single guesses when the alternative was instructed, but differences in total points scored were inconsistent and very small.

Subject #7 also demonstrated sensitive guess performance for shaped and instructed problem pairs, when alternatives were both shaped and instructed. For pairs A and B, total points and most points per guess reached maximal levels with both alternative types. Far fewer points were earned on problem pairs C and D, but effective guess acquisition was apparent with both alternatives. In pair C, points increased more quickly and to a somewhat higher level when the alternative was instructed than when the alternative was shaped. For problem pair D, point earnings increased to an equal level for the two alternatives, although it was attained more quickly when the alternative was instructed.

Guess performance for subject #8 reached maximal levels on both point measures for problem pairs A and B. In problem pair A, total points increased to the maximal level over a number of cycles when the alternative was instructed. Otherwise, the maximal level was reached immediately in pairs A and B. For problems C and D, more points were earned on both measures when the alternative was shaped. In fact, not a single guess was made for either of these problems when there was an instructed alternative, thereby making acquisition impossible.

Subject #9 earned the highest points possible for single guesses with both alternatives in problems A and B, although the same was not true of total points. For problem A maximum total points were attained when the alternative was shaped but not when it was instructed, and the converse was true for problem B. For problem C, more points were earned on both measures when the alternative was shaped. However, this comparison included another example of no guesses made (after the first cycle) when there was an instructed alternative. For problem D, there were increases with both alternatives but more points were earned when the alternative was instructed.

In summary, sensitive acquisition was characteristic of the guess performance in Experiment III, both when the concurrent alternative was shaped and when it was instructed. For instructed problem pairs (i.e., A and B), guessing was equally effective with the two alternatives in every case as indicated by the most effective guess of the cycle. As in Experiments I and II, instructing guesses reliably led to maximum point earnings. Although there was some variance in total point earnings, it more often resulted from the number of guesses made than from a lack of sensitivity to the problem contingencies, as shown by the most successful guess of the cycle. (Given that a guess had contacted the maximum points, the failure to produce as many points as possible by repeating a successful guess five times might be considered insensitive performance. The relative merits of such a conclusion will be discussed at a later point.)

For shaped problem pairs where there was no instruction to prompt maximally effective guess performance, fewer points were earned. Furthermore, the points earned on a problem when the alternative was instructed were not equal to the points earned when the alternative was shaped. However, the differences in point earnings did not vary as a function of the alternative instruction-type. As judged by the most successful guess of a cycle, the following relations were observed. (There was only one case in which the single guess measure and the total point measure showed a different relation. That was problem C for subject #6.) More points were earned when the alternative was instructed in four comparisons; more points were earned when the alternative was shaped in three comparisons (but see below); and the points earned were equal for the two alternatives in one comparison.

Finally, sensitive acquisition was demonstrated on all but three problem versions. In each of these cases however, the failure to develop effective guesses was at least partially due to an absence of contact with the contingencies, rather than an insensitivity to the contingencies. In other words, few or no guesses were made in these cases, and differential consequences could not be applied. It is interesting that each time this pattern occurred, the problem alternative was an instructed one. (These were the same three problem comparisons in which more points were earned when the alternative was shaped). Indeed, there was a very slight overall tendency for more guesses to be made when the alternative was shaped. While the number of guesses was greater when there was a shaped alternative in six comparisons, more guesses were made when the alternative was instructed in only one.(The number of guesses made were very similar for the two alternatives in the other nine comparisons.) Thus, there was some indication that the instruction-type of the concurrent alternative was related to the number of guesses made. (Thus, there was some support for the possibility that the instruction-type of the concurrent alternative could influence guess performance. However, the influence seemed restricted to the number of guesses made rather than their sensitivity.)

Figure 16. Number of points earned on each problem divided by the number of trials completed on that problem. Each data point represents performance on one cycle of computer responding. Filled data points represent performance when the problem alternative's guesses were shaped. Open data points represent performance when the problem alternative's guesses were instructed.

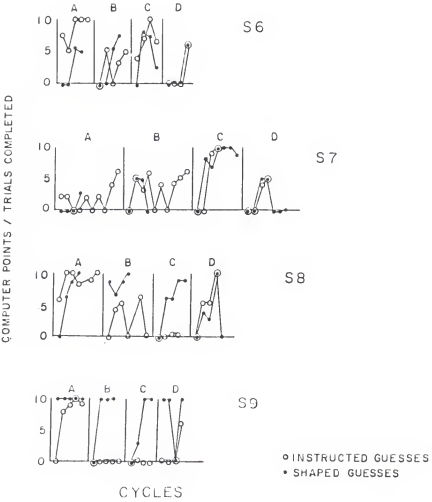

A
B
C
D
10
5
0
S6
S7
S8
S9
COMPUTER POINTS / TRIALS COMPLETED
CYCLES
○ INSTRUCTED GUESSES
• SHAPED GUESSES

Figure 17. Preference Performances. The left panels show the number of trials completed on each problem that differed from standard alternations of problem presentation. The right panels show the number of change-over responses made to produce each problem and the number of change-over responses made to remove each problem. Each data point represents performance for one cycle of computer responding. Filled data points represent performances when the problem alternative was shaped. Open data points represent performances when guesses were instructed.

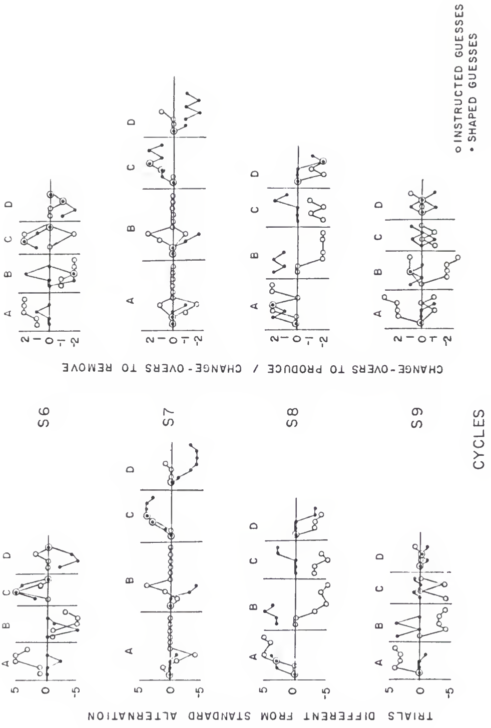
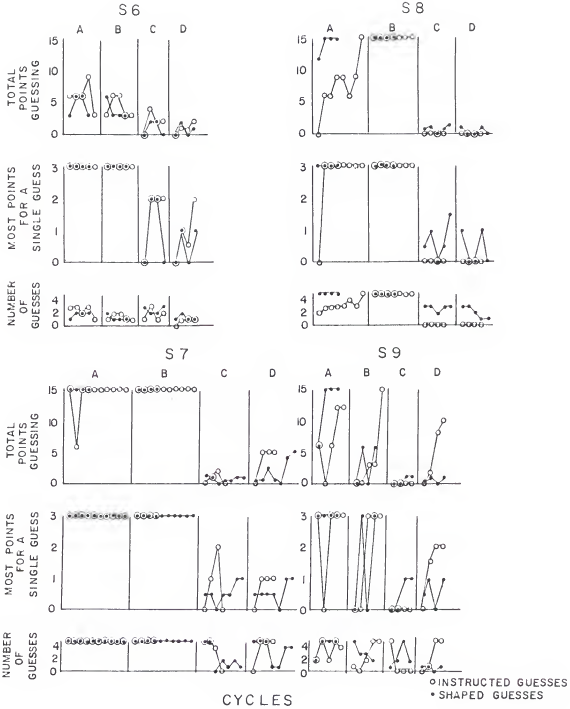

○ INSTRUCTED GUESSES
• SHAPED GUESSES
CHANGE-OVERS TO PRODUCE / CHANGE-OVERS TO REMOVE
TRIALS DIFFERENT FROM STANDARD ALTERNATION
CYCLES
S6
S7
S8
S9
A
B
C
D
2
1
0
-1
-2
5
0
-5

Figure 18. Guessing Performances. The top panel for each subject shows the total number of points earned by guessing on each cycle. The middle panel for each subject shows the most points earned by any single guess on a cycle. The bottom panel for each subject shows the total number of guesses made on each cycle. Filled data points represent performance when the problem alternative's guesses were shaped. Open data points represent performance when the problem alternative's guesses were instructed.


S6
S8
S7
S9
A
B
C
D
TOTAL POINTS GUESSING
MOST POINTS FOR A SINGLE GUESS
NUMBER OF GUESSES
15
10
5
0
3
2
1
4
○ INSTRUCTED GUESSES
• SHAPED GUESSES
CYCLES

In conclusion, Experiment III found no evidence in support of the possibility that instructions for one member of a concurrent pair might have an effect on response sensitivity in the other member of the pair. Instead, sensitivity to point-earning contingencies was most comparable with the two alternative types, both for key-pressing and for gueses. Furthermore, preference for a given problem did not vary as a function of the type of concurrent alternatie, although there remained a preference for shaped problems within shaped/instructed concurrent arrangements. The only evidence that alternative type had any effect on performance came from the finding that the number of gueses made for a problem tended to be higher when the alternative was shaped than when there was an instructed alternative.

## Discussion

Experiment II revealed that when given a choice, subjects would respond so as to produce shaped-guess problem conditions more often than instructed-guess problem conditions. A possible explanation for such a preference would be supplied if the performances under one set of conditions were more sensitive to and therefore more successful with the contingencies imposed. In such a case one might predict that subjects would choose to respond under the conditions in which they were most successful. However, in Experiment II nonverbal responding seemed equally sensitive in the presence of the two conditions. Experiment III addressed the possibility that differences in sensitivity for the two problem conditions had been masked by the fact that both conditions were present at the same time. (An alternative conclusion that might be drawn from these findings is that preference was due to differential reinforcer magnitude in the two conditions, as opposed to differential sensitivity to the contingencies.)

The findings from Experiment III confirmed the relations described for Experiment II. There was no evidence that sensitivity to a given problem contingency varied as a function of the instruction condition of an alternative problem member. Sensitivity was apparent under instructed and shaped guess conditions with either alternative type. Thus, differential contingency-sensitivity would not appear to account for the preference results obtained in Experiment II.

The preference data from Experiment III were also consistent with those of Experiment II. For those concurrent pairs that included both an instructed- and a shaped-guess alternative, some preference was shown for the shaped problem member. Although the preference was not true for all cases, it did occur a majority of the time and it was in the same direction as that observed in Experiment II. When performances on the same problem contingency were compared, the alternative's instruction-type did not consistently predict which presentation would be preferred more often. However, there was an overall tendency for more responding to occur on a particular problem when the alternative was instructed as compared to when the alternative was shaped. This finding would be expected, given a preference for problems with shaped guesses. The trials completed on a given problem would necessarily be fewer if more were being completed on a preferred shaped alternative, whereas the trials available for the problem would be relatively greater if the paired alternative was not a preferred one (i.e., if it was instructed). Thus, another indication of preference was added to that found in Experiment II.

These preference patterns would also be consistent with the view of differential reinforcer values that has been suggested for the two instruction conditions. If reinforcers could be obtained at similar rates in the two alternatives (i.e., if sensitivity were equal under two presentations of the same problem contingency), one would expect preference to be shown for the choice alternative that provided the greatest reinforcer magnitude. Given that differential contingency sensitivity has earned little support as an explanation for these preference data, reinforcer magnitude seems important to consider.

The guessing performances exhibited in Experiment III were also similar to those described in Experiments I and II. Sensitive acquisition was evident for both instructed and shaped problems, especially as measured by the number of points earned by the most successful guess. Instructed guesses again consistently earned more points than did shaped guesses. The major contribution made by Experiment III was the understanding that guess effectiveness for a given problem did not vary systematically as a function of the alternative's instruction-type. Thus, as with nonverbal responding, the failure to find differences in the contingency sensitivity of variously instructed guessing performances did not appear to result from the type of alternative with which a given problem was paired.

Other facets of the guessing performances exhibited in Experiment III deserve mention, as they reproduce or relate to important characteristics of the results discussed in Experiments I and II. Once again there were a number of occasions on which the number of guesses made decreased even though individual guesses were becoming more successful. Even when individual guesses were earning the maximum points, the number of guesses made, and thus the total number of points earned on that cycle, were frequently less than what was possible. As in Experiment II, this pattern was observed both for instructed and for shaped problems. As discussed previously, this might be taken as an indication that the reinforcing value of points earned in addition to problem solutions was relatively low. Similarly, if guesses were maintained only by their point-earning capacity consistently more guesses would be expected in instructed conditions, where point earnings were higher. However, this was not the case.

In considering the results of the previous two experiments, one possibility was that having the opportunity to produce a problem solution might serve to decrease the reinforcing efficacy of points. Some data suggesting that possibility were obtained in Experiment III. When fewer than the maximal number of guesses were made on instructed problems, there tended to be more guesses if the alternative was also instructed than if the alternative's guesses were shaped. It should be noted that this pattern did not hold for every comparison, nor were the differences large when they did occur. However, it was the most common pattern, and it is consistent with many of those already described. If the availability of solution production did decrease the reinforcing efficacy of additional points, fewer instructed guesses should be maintained with a shaped alternative present and indeed, this pattern was observed.

By the same reasoning, the number of guesses made for shaped problems would not be expected to vary as a function of the alternative's type of instruction. Because the shaped guesses already provided the opportunity for both solution production and point accrual, the nature of the alternative would neither add nor subtract reinforcer options. Indeed, the data revealed that the number of comparisons with more guesses when the alternative was shaped approximately equaled the number of comparisons with more quesses when the alternative was instructed.

Within this context however, there was a particular guess pattern that did not mesh easily with the suggested reinforcer-value framework. There were three problems for which no guesses were made, and in each case the problem alternative was instructed. As discussed above, the fact that fewer guesses occurred when there was an instructed alternative is not an issue; however, it is not clear why there should be no responses made at all if solution production was the more valuable response outcome. Here, the number of guesses presents some confusing data with respect to the reinforcer value issue. However, each of the other relations discussed are consistent with the possibility that producing a problem solution may be a more potent reinforcer than additional point accrual.

# CHAPTER V

# GENERAL DISCUSSION

The evidence from Experiments I, II, and III has been interpreted in terms of the way in which instructions influence the reinforcing efficacy of points as consequent stimuli. In short, it was argued that the reinforcing effectiveness of points depended to a great extent on the conditions with which the points were paired. When points were related to acquiring and initially producing a problem solution, they seemed to function as more potent reinforcers than when they accumulated redundantly. In other words, points appeared to have more reinforcing value when they signalled increasing mastery over the contingency than when they were produced in addition to, or in excess of, such mastery (or at least when they did not further the mastery).

There was no evidence that the instructional stimuli provided had any influence on the actual mastery of or sensitivity to reinforcement contingencies. However, findings were described that seemed to indicate that instructions decreased the reinforcing efficacy of points. It may be that after instruction delivery, any points earned were secondary to or functionally redundant with the critical performance elements specified by the instruction. Under these conditions, points provided no indication of mastery beyond that established by the instruction. Skinner (1953) has argued that responding that results from instructions is likely to be given less credit by others than that which is directly shaped by the contingencies (i.e., the two performances are differentially reinforced). A history with such social reinforcement practices may help to account for the greater reinforcing efficacy of points earned in the absence of instructional stimuli.

The implications of these suggestions are interesting to consider with respect to findings from the other investigations of instruction effects. The account just outlined may prove helpful in explaining why instructions do sometimes seem to produce response insensitivy to reinforcement contingencies (e.g., Kaufman, Baron, & Kopp, 1966; Lippman & Meyer, 1967; Matthews et al., 1977; Shimoff et al., 1981; Catania et al., 1982; Matthews et al., 1985; Shimoff et al., 1986). It may be that instructions are not producing insensitivity so much as decreasing the effectiveness of the points that are so often used as consequent events. If points are not effective reinforcers, insensitivity to their scheduling might not be surprising.

It should be pointed out that this is not a novel complaint about points as potential reinforcers. Even when backed up with various exchange systems (i.e., money), their value may be questioned. An unfortunate possibility is that points may gain very little reinforcing value from the range of monetary pay-offs with which they have typically been associated, especially when college students serve as subjects. Instead, it is being argued here that much of the reinforcing value that does exist for points may very well stem from their indicating increasing mastery on an operant task. If instructions can function to lessen or subtract from that back-up, the reinforcing effectiveness of points may be limited indeed and unlikely to support sensitive performances.

An interesting contrast exists, however, in the reports that instructions have sometimes actually increased response sensitivity to the reinforcement contingencies in effect (e.g., Azrin, 1958; Ayllon & Azrin, 1964; Baron, Kaufman, & Stauber, 1969; Scobie & Kaufman, 1969; Frazier & Bitetto, 1969; Weiner, 1970). Again, we might consider the possibility that instructions influence sensitivity via their impact on the reinforcing efficacy of points. If instructions defined the experimental conditions such that points would clearly signal the acquisition of contingency-mastery, those points should function as more potent reinforcers and thereby promote sensitive responding.

In many ways the instructions associated with greater contingency-sensitivity seem to follow such a pattern. One characteristic typical of these instructions is that they completely specify the reinforcement contingency in effect. That is, antecedent and consequent stimuli are detailed, as well as the schedule parameters in many cases. Such instructions functionally define the maximal reinforcement pattern available. Following from the preceding discussion, one result of such a specification may be that points then serve to make progress, or mastery, conspicuous. (Again, Skinner (1969b; 1974; 1978a, b, & c) and others (e.g., Keller & Sherman, 1974; Kulik, Kulik, & Carmichael, 1974) have emphasized that teaching effectiveness is often contingent on making a student's progress or mastery conspicuous.)

It is important to contrast the type of instructions just described with those characterized previously as decreasing the reinforcing effectiveness of points. Even within the present analysis, one factor has emerged as an appropriate distinction between the two instruction-effect categories. Instructions that specify actual response characteristics would appear most likely to decrease the reinforcer-value of points. In short, there may be little reinforcing value in producing points as a result of complying with direct instructions. The points produced by such performances are redundant with the stimuli provided by the instructions and may have only as much value as their exchange rate (e.g., $.02) provides. They are not backed up with other important reinforcer such as evidence of improvement or increasing mastery and in fact have little relation to acquisition. Furthermore, social reinforcement for successful performances might have been least likely, historically, when those performances were directly instructed.

Conversely, instructions that do not specify response dimensions seem less likely to produce such effects. Not only might social reinforcers differ, but without a specification of the behavior to be emitted points are functionally the only indicators of successful performance. They are not redundant with stimuli provided in the instructions. This seems likely to increase their value as consequent events. As the acquisition of successful performance takes place, the increasing frequency of points make developing mastery conspicuous. Indeed, once paired with acquisition, points may even continue to have greater reinforcing value after performance has stabilized. Furthermore, when instructions have detailed the pattern of reinforcers available, points can best serve as indices of attaining a maximal level of mastery. Under these conditions, points would seem likely to be effective reinforcers.

These predictions do have some empirical validity. Matthews et al. (1985) differentiated between what they termed performance and contingency instructions and reported that performance instructions were more likely to produce contingency insensitivity. In addition, a survey of the instructions used in studies reporting schedule-insensitivity reveals an overwhelming preponderance of performance descriptions (for example, press the key slowly) (e.g., Shimoff et al., 1981; Catania et al., 1982; Hayes et al., 1986a; Hayes et al., 1986b), while studies reporting increased sensitivity from instruction delivery are typified by contingency descriptions (for example, the button will only work again after 60 seconds have passed) (e.g., Baron & Kaufman, 1968; Scobie & Kaufman, 1969; Baron, Kaufman, & Stauber, 1969; Frazier & Bitetto, 1969; Weiner, 1970). These relations might be taken as supportive of the view that instructions influence the reinforcing efficacy of points by arranging differing relations with mastery.

In concluding this discussion, it is interesting to compare the present analysis with the accounts of instruction effects, described previously, by other researchers. First, the present argument contrasts directly with the view that instructions decrease contingency-sensitivity by definition (e.g., Shimoff et al., 1986; Lowe 1979, 1983; Bentall et al., 1985). It is argued here that under the proper conditions sensitive performances may be obtained in the presence of both instructed and shaped rules. Indeed, one might consider how appropriate it is to argue that any performance is insensitive to reinforcement. At some level, such an argument seems tatamount to forgoing a functional definition of the term.

In contrast, an account more in keeping with a functional analysis of behavior emphasizes the way in which instructed responding contacts reinforcement contingencies. This approach toward explaining instruction effects is held in common by the present analysis and those of Baron and Galizio (1983), Hayes, et al. (1986a, 1986b), and others (Perone et al., in press). The latter accounts have focused primarily on the degree to which instructed behavior can be supported by the contingency-structure and on the extra-experimental contingencies for following instructions, respectively.

The present analysis suggests that another mechanism may mediate the influence of instructions, as well. Sensitivity to contingencies must depend, to some extent, on the reinforcing value of the consequent events and it has been argued here that in certain circumstances, instructions may influence the reinforcing efficacy of some types of consequences. By some analyses (Catania, 1979), this would put instructional stimuli into the category of motivational variables (i.e., those conditions that "make consequences more or less effective as reinforcers or punishers"; Catania, 1979, p.65). Thus, the emphasis on contingency contact is maintained in the present account. What is added by it is a) a focus on the nature of the contacted stimulus, and b) a reminder of the relativity of reinforcement (e.g., Catania, 1979; Premack, 1959, 1962, 1971) and the fact that stimulus characteristics can only be identified by their effects on an organism's behavior.

It is not suggested here that the present account and those others that have emphasized contingency contact (e.g., Galizio, 1979; Baron & Galizio, 1983; Hayes et al., 1986a, 1986b) are mutually exclusive. Indeed, these explanations are likely to prove most powerful when their respective focuses are considered in combination. For example, Baron and Galizio's (1983) explanation of contingency-sensitivity has argued that instructions may produce responding that prevents contact with the schedule structure. This argument has been criticized for being unable to explain data that reveal insensitivity even after contact has been imposed (Hayes et al. 1986b). However, the present account might be invoked to complete the explanation. Contacting a change from a richer to a leaner schedule, or even extinction, may not constitute contact with a change in reinforcement rate if the consequent events had little or no reinforcing value. In other words, response patterning may not vary with changes in the scheduling of point consequences because no change in the level of reinforcement has occurred.

This analysis also has implication for future research of both a practical and a conceptual nature. Although the present discussion may seem to discourage the practices of using instructions and point consequences in human operant investigations, this is an incorrect conclusion. Instead, the variables discussed may be employed to a researcher's advantage. Instructions might be designed to define mastery (for example, by specifying the maximal reinforcement rate), but not to describe the performances that would produce mastery. Such instructions could function to increse sensitivity to scheduled events (like points) by establishing them as indicators of mastery acquisition, thus producing reinforcer effectivenss. Furthermore, even though instructed, sensitivity would still be required of the responding in order for reinforcers to be obtained, and criticisms of "pseudosensitivity" (Shimoff et al., 1986) would not be an issue. The potency of task mastery as a reinforcer could be effectively put to use by employing an explicit problem-solving task such as the one in these experiments. Other possibilities also exist, the repeated acquisition procedure being a notable example. The opportunity for acquiring or increasing mastery is a continuous feature of both of these procedures. The performances exhibited in Experiments I, II, and III illustrated that point accrual can maintain active, sensitive responding under such conditions. (The collateral behavior patterns shown by the subjects in this research were also notable as indicators that points were effective reinforcers, and the absence of points aversive.)

The present analysis also suggests further research directions at a more conceptual level. The importance of analyzing motivational interactions between instructional stimuli and contingencies and their effects on responding has now been added to the tasks necessary for completing an understanding of instructional control. In this light, reports of sensitive instructed performances maintained by nonarbitrary consequences as opposed to socially mediated ones (Hayes et al., 1986a, 1986b; Hayes et al, 1985; Hayes & Wolf, 1984; Rosenfarb & Hayes, 1984) such as points worth pennies seem even more intriguing. Such reports support the present analysis and the need for further exploration. Further investigation into these facets of instructional control may prove to clarify and explain the discrepancies in instructional effects on contingency-sensitivity that have become so widely debated in the human operant literature.

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# APPENDIX

## INSTRUCTIONS

This experiment is designed to investigate how people learn to solve complex problems. Your job throughout this experiment will be to try to earn as many points as possible. You will be paid 5 cents for each point you earn. The number of points you earn is an indication of how well you are able to figure out all aspects of complicated problems.

You have two different ways of earning points - 1) by working on the computer, and 2) by guessing.

### The computer

You can earn points by working on the computer in the following way. Before you, on the computer console, you can see a 5 x 5 grid of squares. The square in the top, rightmost corner is solid. You are to move the solid square from its starting point to the bottom, leftmost corner of the grid. There are four types of allowed moves to get the solid square to this target position. Pressing the down arrow key on the computer will move the solid square one space down; the left arrow will move the square one space to the left; the up arrow one space up, and the right arrow one space to the right. At any given time, there are a number of ways to move the solid square to its target that will earn points. If you press the keys in one of the right sequences you will notice that a point is added to your cumulative point total when you reach the target position. This total will be shown on the lefthand side of your computer screen.

## Guessing

Another way to earn points is by guessing. Every few minutes, I will tell you to stop working on the computer. At this time you should move to the chair directly behind you and take one of the guess sheets in front of you. Fill in as many blanks as you can on the guess sheet. Don't take longer than about 4 minutes - then pass the sheet to me. After a minute or two, I will pass the sheet back with your point earnings written beside each guess. You can earn from 0 to 3 points for each guess.

Your guesses should try to identify what is required of each sequence of moves in order to earn a point. The closer the guess is to explaining all of the possible point-earning patterns, the more points it will earn. Guesses should not be descriptions of any one specific pattern. For example, there are many different patterns for getting to the goal position that move through the very center position on the grid. If each pattern that moved through the center earned a point, and the center position was the only feature the patterns had in common, then a guess that specified the center position would earn the maximal number of points. After you have seen your points for each guess, pass the guess sheeet back to me and begin working on the computer again. You will fill out another guess sheet when I tell you that it is time to guess again. Sometimes you will be given clues about how to guess.

We will continue this same procedure--working on the computer and guessing--throughout each of your sessions. Remember that your job is to earn as many points as possible. If you have any questions about the instructions I can answer them at this time. Any other questions will be answered at the end of your participation. Also, please note that once the experiment begins I will not be able to talk with you at all so please ask any question or make any comment now.

# BIOGRAPHICAL SKETCH

I was born in Richmond, Virginia, on May 21, 1956. I attended public school in Richmond through grade 12 and graduated from John Randolph Tucker High School in 1974. I entered Virginia Polytechnic Institute and State University in the Fall of 1974 and graduated with a B.S. in psychology in 1978. In the Fall of 1978 I began the doctoral program in experimental analysis of behavior in the Psychology Departent at the University of Florida. I received my M.S. in August, 1983.

I am a member of the Association for Behavior Analysis, the Southeastern Association for Behavior Analysis, and the Experimental Analysis of Human Operant Behavior Special Interest Group.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Henry S. Pennypacker

Henry S. Pennypacker, Chairman
Professor of Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

James M. Johnston

James M. Johnston
Professor of Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Edward F. Malagodi

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Merle E. Meyer
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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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This dissertation was submitted to the Graduate Faculty of the Department of Psychology in the College of Liberal Arts and Sciences and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

December, 1987

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